A Feasibility Study of Using SGRT for Esophagus Tumors

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Purpose

Surface Guided Radiation Therapy (SGRT) as an emerging treatment technique has been adapted to treat breast tumors and lung tumors. The aim of this study was to evaluate the feasibility of using surface guided imaging system for patient positioning as an alternative of cone-beam computed tomography(CBCT) before each fraction and for motion tracking during the treatment in Lateral (L/R), Longitude (S/I), and Vertical (A/P) directions.

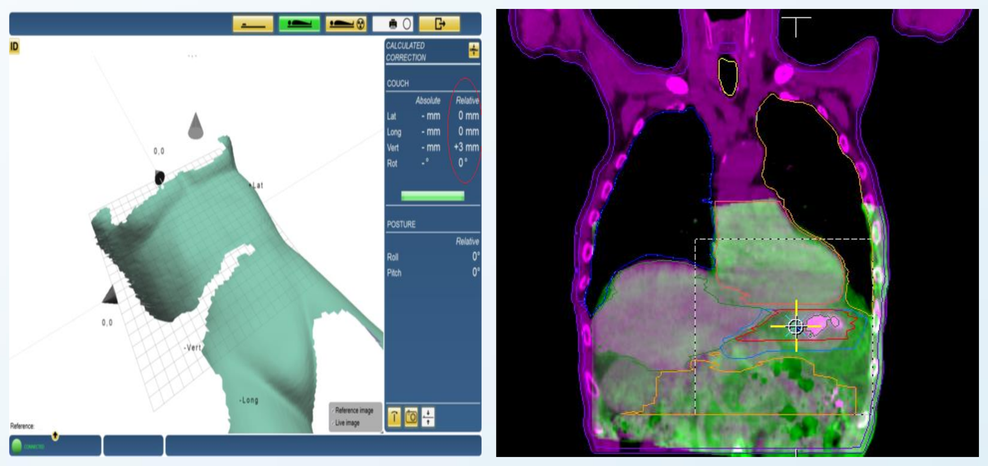
Methods & Materials

CatalystHD

- A surface mapping system which consists of 3 high resolution cameras was first used to capture the patient's fractional setup error.

Patient Setup Verification

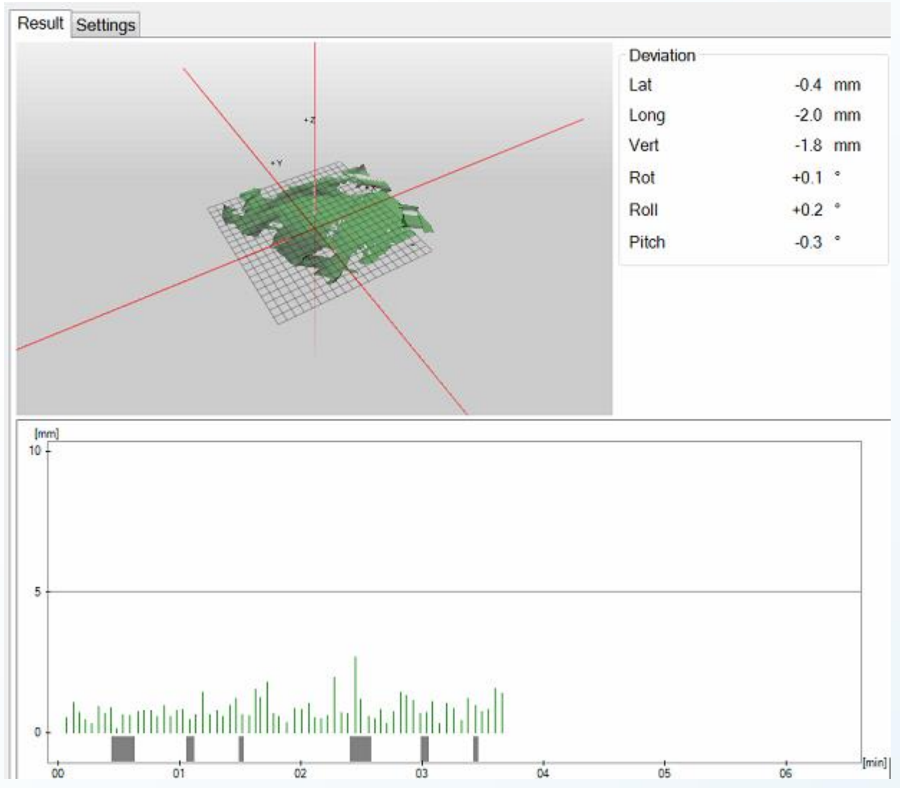
- The kV-CBCT was acquired immediately following to adjust for any residual corrections. The difference between the setup errors obtained from CatalystHD and CBCT were retrospectively compared.



Methods & Materials

Intra-fractional Motion Tracking

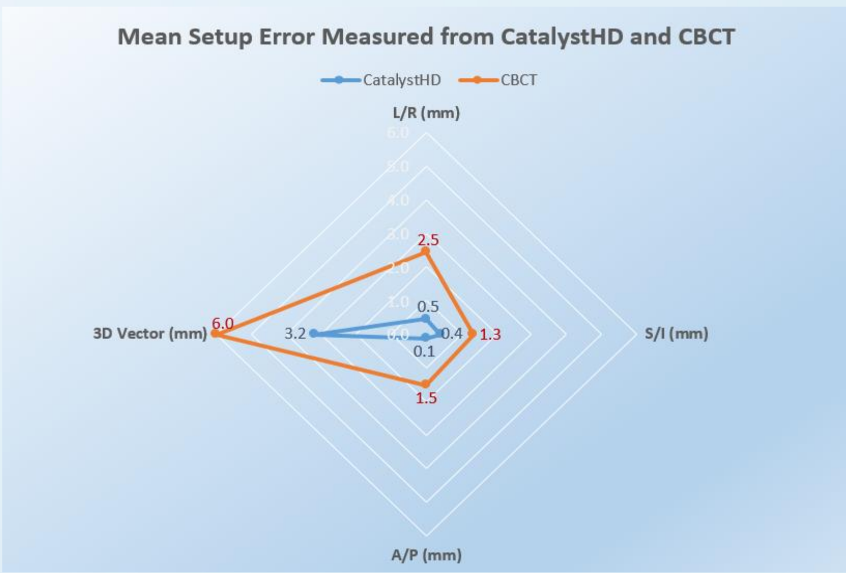
- A virtue point was placed on the surface of patient's chest, which was used to monitor patient's motion during the treatment (see figure below and grey bars on the timeline indicate the beam is on) and recorded as a list of tracking points by the CatalystHD. The ranges of motion in three directions and the 3D shift vectors were statistically analyzed.



Results

Setup Errors from CatalystHD and CBCT

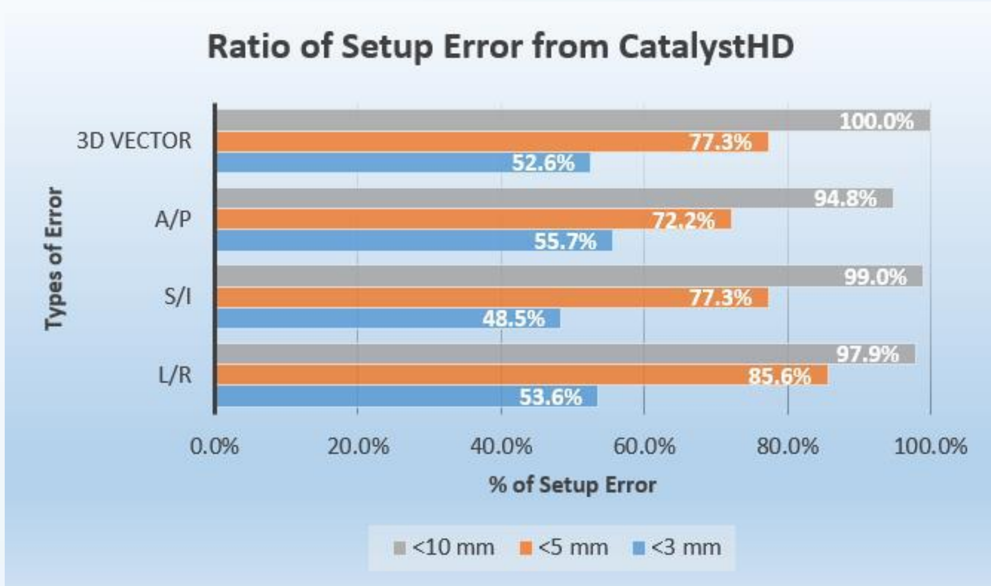
- The average difference between the setup errors obtained from CatalystHD and CBCT were -2.0 ± 3.6 mm, -0.9 ± 4.6 mm, -1.4 ± 5.2 mm, and -2.8 ± 2.8 mm for L/R, S/I, A/P, and 3D shift vectors, respectively. As shown in figure below, CatalystHD underestimates the mean setup errors compared with CBCT in all directions, which could be due to the triangulation approach and a non-rigid algorithm used in CatalystHD system to match the surface isocenter with the reference image.



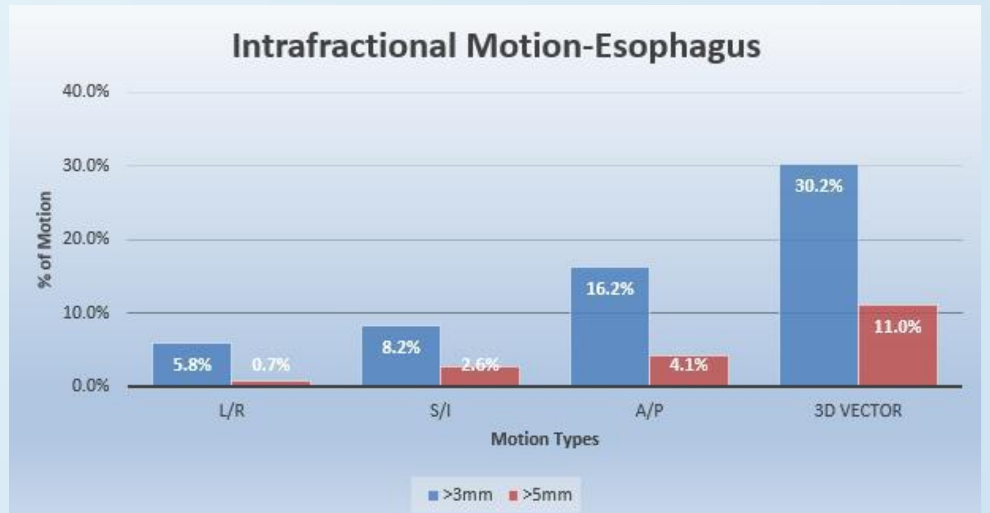
Results

Intra-fractional Motion Tracking

- Among 97 fractions, the ratios of the difference less than 5 mm were 85.6%, 77.3%, 72.2% and 77.3% for L/R, S/I, A/P, and 3D shift vectors, respectively. The ratios of the difference less than 10 mm were 97.9%, 99.0%, 94.8%, and 100% for L/R, S/I, A/P, and 3D shift vectors, respectively (shown in figure below).



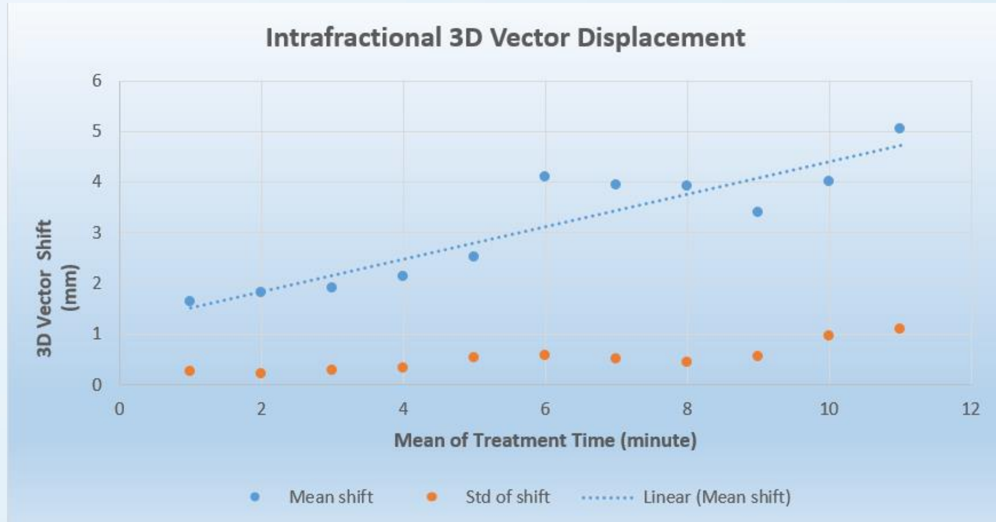
- Among 15,449 tracking points as shown in figure below, the ratios of motions more than 3 mm were 5.8%, 8.2%, 16.2%, and 30.2% for L/R, S/I, A/P, and 3D shift vectors, respectively. For motions more than 5 mm, the ratios were 0.7%, 2.6%, 4.1%, and 11.0% for L/R, S/I, A/P, and 3D shift vectors, respectively.



- The average of intra-fractional motion were -0.2 ± 1.4 mm, 0.1 ± 1.7 mm, -0.4 ± 2.2 mm, and 2.4 ± 2.0 mm for L/R, S/I, A/P, and 3D shift vectors, respectively. The maximum motions for L/R, S/I, A/P directions are 8.1 mm, 10.3 mm, and 11.4 mm, respectively.

Results

- 3D shift vectors in figure below showed good correlations with treatment time (R=0.91) and a linear function ($y = 0.3217x + 1.1922$) was established to predict the 3D vector displacement by treatment time.



Conclusions

- CatalystHD can be a promising periodical alternative of CBCT for esophagus patient setup if the target has a margin equals or more than 10 mm. Special cautions should be taken for the case which has a margin smaller than 10 mm when only use CatalystHD.
- The intra-fractional motions of esophagus patients vary and have significant deviations, which should be monitored during the esophagus treatment.
- In order to use a small margin for the target, the treatment time should be reduced. The surface imaging system such as CatalystHD can be considered as a viable option for esophagus patient setup and intra-fractional motion monitoring, which guarantees the accuracy of delivery and patient's safety.

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