shift was determined by maximizing a correlation coefficient between these signals. A new 4D model corrected for the phase shift was then created. Subsequently, impact of the corrected 4D model on tracking accuracy was examined. During IR tracking irradiation, we acquired kV X-ray images every 1 s. Detected and predicted tumor positions were calculated from the fiducials on the kV x-ray images and the 4D model, respectively. The tracking errors, defined as the difference between these tumor positions, were compared between without and with the phase shift correction in a total of 4186 frames.

Results: Maximum phase shifts were 1092, 124, and 1047 ms in the LR, CC and AP directions, respectively. With the phase shift correction, means+2SDs of absolute error of 4D model were decreased by up to 0.31, 0.20, and 0.76 mm in the LR, CC, and AP direction, respectively. Considering the lung tumor motions, the amount of phase shift, and the reduction in the error of 4D model, the phase shift correction was applied only to the motion in the AP direction. The 95th percentiles of the tracking errors were decreased for all patients by the phase shift correction (Table).

Conclusions: This preliminary study demonstrated that phase shift correction might be effective in reduction of the tracking errors for patients with large tumor motion and phase shift.

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The Immobilization Performance of a Novel "Open-Face" Mask Used for the Setup of Claustrophobic Patients Being Treated for Head-and-Neck Cancers

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Purpose/Objective(s): The importance of immobilization during the precision radiation therapy (RT) era cannot be underestimated. However, patients who suffer from claustrophobia have difficulty undergoing head/neck (HN) RT using the conventional mask. As a result, these patients will forgo the treatment which can cause tumor progression/recurrence or require heavy doses of daily relaxants to complete HN RT. We, therefore, developed a reinforced "open-face" mask with the goal of aiding claustrophobic patients to complete RT by minimizing the sensation of enclosure or inability to escape that is experienced with the conventional HN mask. We present our preliminary data comparing this "open-face" to the conventional mask in terms of their ability to immobilize patients.

Materials/Methods: An open-face mask featuring a cutout that leaves the eyes, nose and mouth exposed was developed and used for 5 claustrophobic patients undergoing HN RT. Integrated strengthening panels were incorporated to compensate for any loss in integrity. Shifts in patient position during treatment were measured using pre and post treatment KV images. A total of 85 post-treatment image pairs were registered directly to the corresponding pre-treatment pairs to determine the shift. A group of 8 patients with conventional masks treated during the same period also with pre-and post KV imaging was used as control (82 sessions in total). The distributions of the 3D absolute displacements of the cranium, lower jaw and C6 using the open-face mask were compared with those of the conventional mask.

Results: The mean and standard deviation of the 3D shifts during treatment for the conventional mask versus "open mask" were 1.2 $\pm$ 0.7 mm vs. 0.7 $\pm$ 0.8 mm; 1.9 $\pm$ 1.1 mm vs. 1.0 $\pm$ 0.8 mm; and 1.5 $\pm$ 1.3 mm vs. 1.3 $\pm$ 0.9 mm for the cranium, lower jaw, and C6, respectively. The distributions of the cranium and lower jaw "open-mask" absolute displacements were statistically different in favor of the "open face" mask with corresponding P-values of 0.002 for the cranium and 0.002 for the lower jaw respectively. There was no difference for C6, p = 0.32 between the two masks.

Conclusions: Our preliminary data showed that the "open-face" mask lead to a better immobilization of the cranium and lower jaw than the conventional mask. Based on approximately 160 registrations of pre- and post-treatment KV imaging, we conclude that an "open-face" mask provided robust immobilization and can be safely considered for use in radiation therapy for claustrophobic patients and potential for all HN cancer patients undergoing radiation therapy.

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Implement of Passive Breath Gating Equipment for Cone Beam CT Guided Volumetric Modulated Radiation Therapy in Gastric Cancer Treatment: Preliminary Results

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Purpose/Objective(s): Respiratory induced organ motions affect the target coverage and normal tissue sparing in abdominal radiation therapy if not properly managed. Breath-hold is an effective method to reduce the respiratory motion and minimize the delivery time. In this study we reported the preliminary results of a passive breath gating (PBG) equipment for cone beam CT based volumetric modulated radiation therapy in the gastric cancer.

Materials/Methods: A PBG equipment developed in our department was integrated with the real-time position management system (RPM) for passive patient breath hold. This system was used in the CT simulation, online breath-hold CBCT (BHCBCT) acquisition and treatment delivery for three gastric cancer patients. The patient's breath hold was triggered by PBG device at the end of the exhale phase with a 3mm breath-hold window. With training patients were able to hold their breaths for at least 20 seconds. A VMAT treatment plan was designed with a single arc of 270° for each patient on planning system. Prior to the treatment delivery, online CBCT was performed with the PBG-RPM system. During the continuous CBCT acquisition, PBG device was manually triggered to block the patient's breathing for 20 seconds or longer and then released to free breathing (FB) for 10 seconds alternatively until the completion of the breath-hold CBCT (BHCBCT) scanning. The gated VMAT treatment was delivered in 4 to 6 breath-holds. The beam was held off for 10 seconds between two breath-holds so that patient could breathe freely before the treatment delivery resumed in next breath hold. Additionally, the intra- and inter-fractional diaphragm motions were investigated.

Results: All patients held their breaths for more than 20s. A total of 75 fractions of gated VMAT treatments were successfully delivered with PBG-RPM system. The average time to setup PBG-RPM system was 3 minutes (range from 2 to 4 min). The BHCBCT images could be acquired in a continuous fashion with 2 to 3 breath hold (20 to 25s each) and 1 to 2 FB break (8s each). BHCBCT did not require more time than FBCBCT. Compared to FBCBCT, the motion artifacts on BHCBCT images were reduced and the diaphragm edge could be restored. The average gated VMAT delivery time for 3 patients was 107s, 142s and 146s, respectively. The intra- and inter-fractional diaphragm motions were within 3mm for all fractions.

Conclusion: In gastric cancer radiation therapy, the integrated PBG-RPM system improved the CBCT image quality without additional scanning time. Compared to other gating methods, PBG system could reduce the respiratory-related motions and RPM provided real time motion monitoring. The gated VMAT treatment could be delivered within 2.5mins. The PTV margin maybe reduced with this system.

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