Voluntary breath-hold monitoring: a comparison of an in-house laser-camera and an integrated gating system David Bernstein[1] (David.Bernstein@rmh.nhs.uk), Katie Kettlewell[1], Lee Corsini[1], Jamie Callan[1], Alison Ranger[1]. [1]Royal Marsden NHS Foundation Trust.

Introduction

Patients undergoing breast radiotherapy are often treated in voluntary breath-hold. Locally, radiographers guided and monitored breath-holds using an in-house laser and camera system. However, this can be subjective and relies on in-house equipment. An alternative approach uses the automated in-built Varian TrueBeam gating system and Respiratory Gating for Scanners (RGSC) on CT, which uses and tracks a reflector block positioned on the patient.

Aim

An observational study of patients treated using the laser-camera system was performed to determine TrueBeam gating system parameters that resulted in at least comparable gating window widths.

Materials and Methods

Fifteen patients participated in the study. The laser-camera system was used to guide and monitor patients' breath-holds during CT and treatment. Simultaneously, the reflector block was positioned and the RGSC and TrueBeam gating system amplitude data collected for retrospective analysis. To assess the reliability of the reflector block data, changes in anterior-posterior separation between CT and CBCTs in breath-hold were compared against changes in amplitude measured using the reflector block.

Results

Figure 1 shows the difference in median breath-hold amplitude, recorded by the reflector block, between treatment and CT for each breath-hold. Data was excluded from one patient due to inconsistent block positioning. Mean ± one standard deviation median breath-hold amplitude differences between treatment and CT were +1 ± 4 mm. Showing considerable inter-fraction variation in the breath-hold amplitude. However, intra-fraction breath-hold variations were small, with a 1.0 mm average standard deviation of median breath-hold amplitude within a fraction. Seventy percent of fractions had breath-hold amplitudes within -3 mm and +5 mm of the median CT value; this was set as the new gating thresholds using the reflector block.

Table 1 shows the correlation between changes in anterior-posterior separation as measured by CT-CBCT and the reflector block. Overall, a weak-to-moderate, albeit statistically significant, correlation was found between the two. Correlations varied between patients.

Conclusion

This study enabled a safe transition from manual laser-camera based breath-hold monitoring and gating, to automatic breath-hold gating using the RGSC and TrueBeam gating systems. The in-house laser-camera system resulted in breath-hold amplitudes that, whilst consistent within a fraction, varied significantly between fractions. Similarly, the amplitude of the breath-hold represented by the reflector block only had limited agreement with the imaging data. Therefore, these systems must not be relied upon alone to assess the quality of breath-hold. The TrueBeam gating system has replaced the laser-camera system, with thresholds set to achieve more consistent breath-hold amplitudes.

Figure 1: box plot showing the median treatment breath-hold amplitude minus the median planning CT amplitude, for each breath-hold, as measured using the TrueBeam gating system or RGSC on CT for different patients. Patient breath-hold was guided and monitored by radiographers using an in-house laser-camera system. The horizontal lines show the resultant determined gating thresholds relative to the planning CT amplitude. The light blue dashed box is from a patient with inconsistent reflector block positioning between CT and treatment.

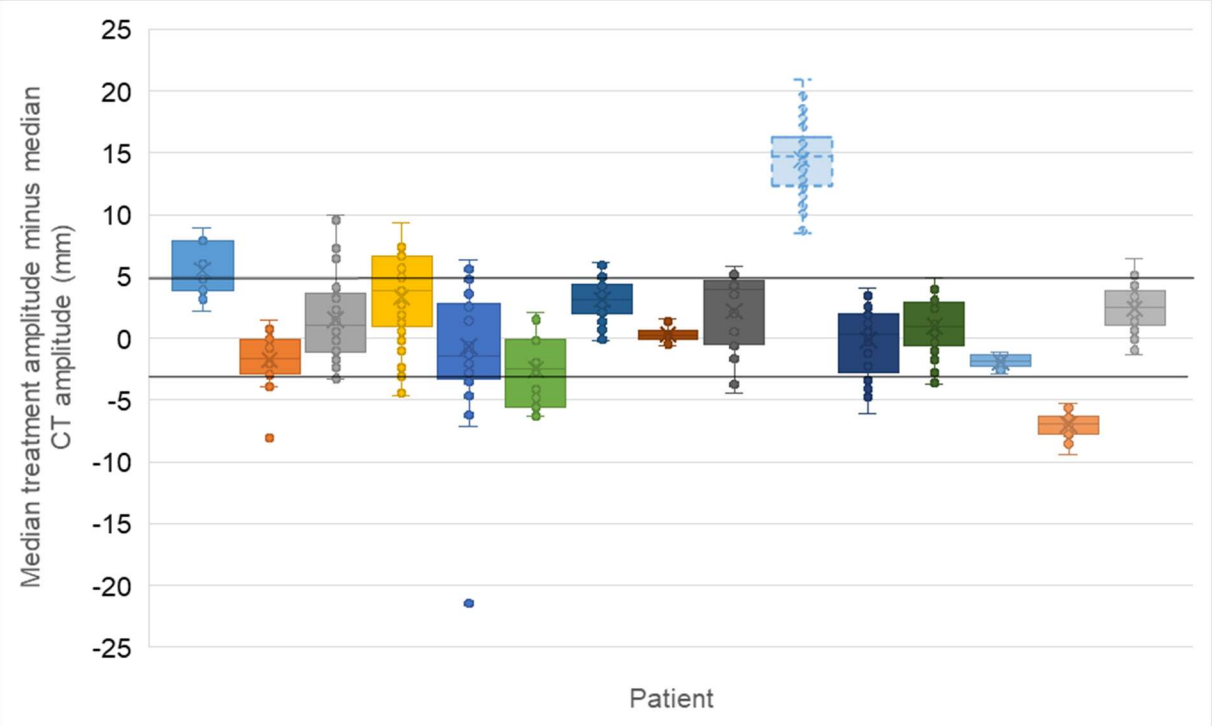

Table 1: The correlation between the CBCT minus CT anterior-posterior separation and median gating block amplitude during CBCT, minus median gating block amplitude during CT. Statistical significance was measured for all patients combined to avoid the statistical issues associated with multiple comparisons. N/A = not applicable.

Patient	Pearson correlation coefficient	Number of fractions	P-Value
All	**0.37**	**99**	**<0.001**
1	0.80	15	N/A
2	-0.70	4	N/A
3	0.38	5	N/A
4	0.44	15	N/A
5	0.63	15	N/A
6	0.60	15	N/A
7	0.66	15	N/A
8	0.64	15	N/A