Comparing the stability of deep inspiration breath-holds between ABC and VisionRT during breast irradiation

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Introduction

Motion management is an important consideration in radiation therapy to help reduce dose to organs at risk. One site where motion management is very important is during left breast irradiation, where the heart close to the field edge. Therefore, stable, deep inspiration breath-holds (DIBH) are often used to reduce heart dose for mitigating cardiac toxicity. DIBH can be accomplished in a number of ways such as the active breathing coordinator (ABC) and VisionRT methods are popular. However, it is unknown which method is more stable in a clinical context. The purpose of this study is to compare the performance between the ABC and VisionRT technologies for producing consistent DIBH during left-sided breast treatment.

Materials & Methods

A series of eight patients, all with left-sided breast cancer, were enrolled in an IRB approved protocol where DIBH was performed for treatment. The total fractionation scheme for these breast patients was 5040 cGy in 28 fractions using the three-field SCV and tangent technique. The first 14 fractions of the 28 fraction treatment employed either ABC or VisionRT and the last 14 employed the other. The orders of the techniques were randomized. During treatment, intra-fraction motion was determined primarily by utilizing MV cine imaging capabilities. A series of MV images were acquired for a single DIBH in each fraction. The MV imaging series were exported from the record and verify system and were analyzed by: 1) Manually contouring the Lung after application of a CLAHE filter, 2) Calculating the Center of Mass Position of the lung, and 3) Calculating the tidal area of the lung. The overall stability of each method, therefore, was determined by assessing the standard deviation of items 2 and 3 above. In addition, the overall fractional treatment times were also compared.

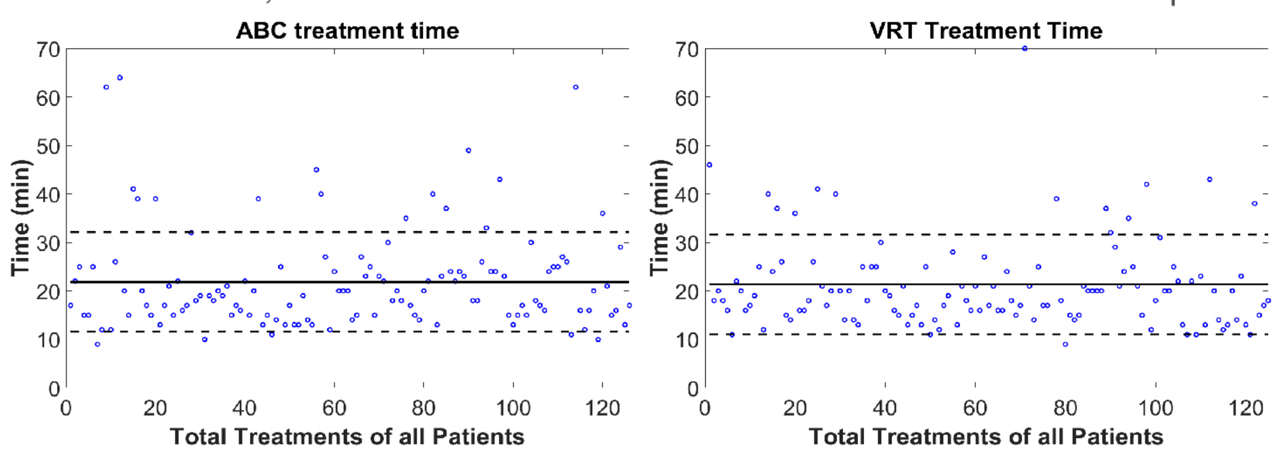

Figure 1. The total treatment times are displayed for all of the patients' treatments. The solid black line shows the mean, and the dotted black line shows standard deviation.

Results and Discussion

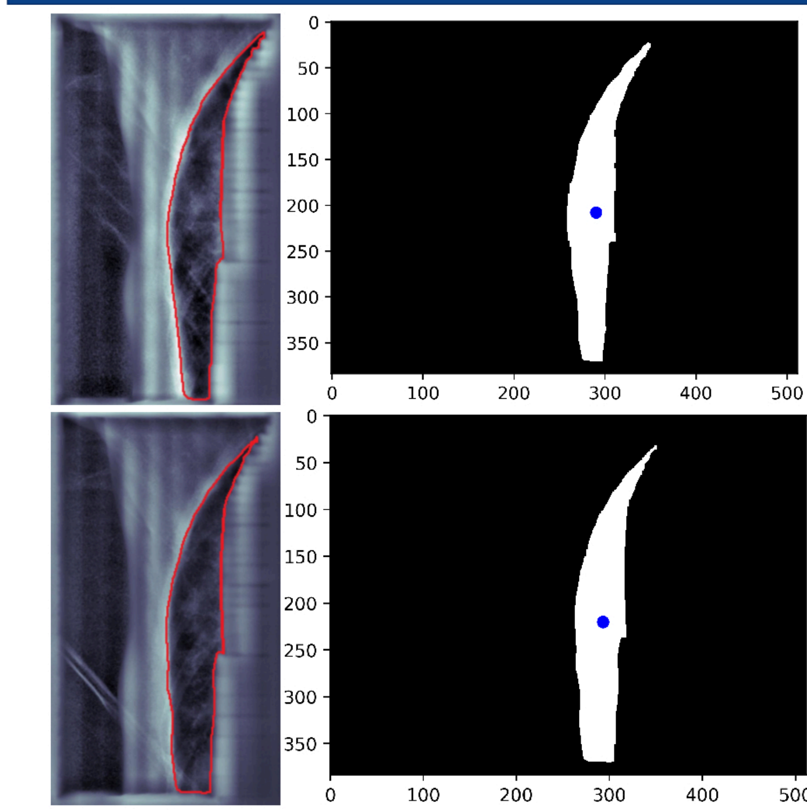

Figure 2. Left: Contoured, CLAHE filtered MV images from the left lateral tangent field. Right: Tidal area is counted as the number of segmented voxels and the blue dots show the position of mass center.

Avg Std Dev. (mm)	VRT	ABC	P-value
SCV field	1.78	2.34	0.321
L Lat field	5.18	5.25	0.959

Table 1. The average inter-fraction standard deviation of the center of mass distance from a reference point (inferior-medial field edge) of the supra-clavicular field and left lateral tangent field.

Avg Std Dev. (cm^2)	VRT	ABC	P-value
SCV field	1.82	2.01	0.721
L Lat field	4.03	6.02	0.0137*

Table 2. The average inter-fraction standard deviation of the tidal area of the supra-clavicular field and left lateral tangent field. The asterisk indicates significance ($p<0.05$) based on a Student's T-test.

Results

The supra-clavicular fields show an interfraction standard deviation of ~2 mm, whereas the left lateral fields show an interfraction standard deviation of ~5 mm for all patients. The tidal area does show statistically significant differences between the VRT and ABC breath-holds for the left lateral field. When looking at only the x position of the center of mass, there is a significant difference between VRT and ABC as well (VRT = 1.62, ABC = 2.25, p=0.0129). This means that the area differences are largely attributed to lung expansion in the x-direction, which may be seen in Figure 2 for one patient.

Discussion

While the data indicates that VRT may be more stable than ABC for DIBH, based on lung positioning/tidal area, the medial lateral tangent data still needs to be fully analyzed to draw this conclusion. The impact of these stability differences on heart dose will be investigated.

Conclusions

VRT appears to be more stable than ABC for DIBH based on the results of lung contour stability, however more data need to be analyzed and experimentally acquired in the future to cement this claim.