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Imaging investigation of small motion target for lung stereotactic body radiotherapy (SBRT)

Abstract

Purpose: Motion management is important in lung tumor SBRT. Small target four-dimensional computed tomography (4DCT) imaging could give significant target motion information. In this study, Quality of 4DCT for small target was investigated to provide information for treatment planning in SBRT of small target, which is in favor of magnifying the target margin characteristics during 4DCT scan.

Method and Materials: A Real Time Position Management (RPM) phantom from Varian Medical System and 6 CT-spot pellets from Beekley Medical were employed for this study. Each pellet was equivalent to a 4mm diameter ball. The CT spot pellets were attached to the RPM phantom. Two pellet set planes formed 8cm distance and generated two speeds which were 0.2cm and 0.4mm per second given a period with 5.0 seconds. With a GE LightSpeedTM RT CT scanner, the phantom was executed with helical scan with 1.25mm slice thickness with and without motion. Then a 4D CT scan in axial cine mode was carried on at the same phantom. The image exams were exported the GE Advantage Workstation for process. The exams were reviewed and sorted into 10 phases retrospectively. The 0% phase image set, 50% phase image set, maximum intensity projection (MIP) image set, and average intensity projection (Ave-IP) image set were exported to the Eclipse treatment planning system for analysis. In image sets, multi-dimensional variables such as center coordinate of pellets, distance between pellets, and volume of the pellets were used for analysis.

Results: At 350 HU window width and 40HU window level, image sets from helical scan for the static phantom is used as reference, comparing to helical scan from moving phantom, retrospective MIP, average intensity projection, 0% phase and 50% phase, for pellets moving at 0.4 cm per second, the average coordinate deviation are 0.49cm, 0.22cm, 0.19cm, 0.59cm and 0.06cm with standard deviation 0.83cm, 0.29cm, 0.32cm, 0.69cm, and 0.07cm, the percentage distance differences are 10.2%, 3.3%, 7.3%, 0.1%, and 0.1% with standard deviation of 13.2%, 4.4%, 9.6%, 0.1%, and 0.1%. and the percentage volumes changes are 17.4%, 171.5%, 18.4%, 14.2% and 7.8% with standard deviation at 25.4%, 201.8%, 23.7%, 19.85% and 10%.

Conclusions: A simple and sensitive 4DCT quality assurance method was developed by combining Varian RPM phantom and CT-spot pellets from Beekley Medical and it shows that the 50% phase image set is better for SBRT planning. Further study will include dosimetric effect on the small target moving in different directions.

Keywords: Stereotactic Body Radiotherapy, small target, motion management, 4DCT

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Introduction

Motion management is important in Lung tumor SBRT.[1,2] Most of 4DCT studies focus on relative larger targets, which determine different SBRT motion management methods. Small targets could be studied for different locations and imaging modalities.[3-6] There are some special characteristics for moving small targets. For example, the relationship between the true volume and motion volume generated by CT imaging is significant. Moreover, during the treatment planning and the dose delivery, margins are usually added to avoid missing target. The potential target dose deficiency could possibly appear at the margin region. Small target 4D CT study could give significant target margin information. In this study, 4DCT for small target was investigated to provide information about the treatment planning strategy in SBRT for small target, which in favor of magnifying the target margin characteristics during 4DCT scan. The phantom study provides us information about the solid target variation information, which supply more accurate information about the tissue small target.

Materials and methods

A Real Time Position Management (RPM) phantom from Varian Medical System and 6 CT-spot pellets from Beekley Medical were employed for this study. Each pellet was equivalent to a 4mm diameter ball. The CT-spot pellets were attached to the RPM phantom. Figure 1 shows the setup. Two pellet set planes formed 8cm distance and generated two speeds which were 0.2cm and 0.4mm per second given a period with 5.0 seconds. With a GE LightSpeed™ RT CT scanner, the phantom was executed with helical scan with 1.25mm slice thickness with and without motion. Then a 4D CT scan in axial cine mode was carried on at the same phantom. The image exams were exported the GE Advantage Workstation for process.

The exams were reviewed and sorted into 10 phases retrospectively. The 0% phase image set, 50% phase image set, maximum intensity projection (MIP) image set, and average intensity projection (Ave-IP) image set were exported to the Eclipse treatment planning system for analysis. Figure 2a-2e shows the volume of motion pellets at

different image sets at 350HU window width and 40HU window level. And then, in image sets, multidimensional variables such as center coordinate of pellets, distance between pellets, and volume of the pellets. Figure 1 displays the Phantom and Pellets for this study.

Figure 1 Phantom and Pellets for this study.

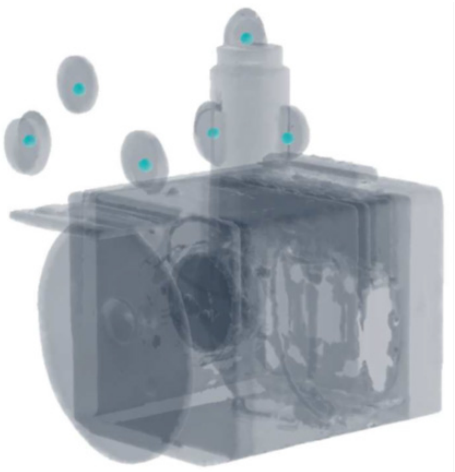

Figure 2a Helical static scan.

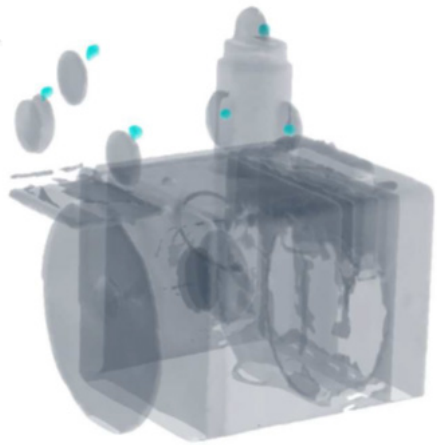

Figure 2b 0% phase image.

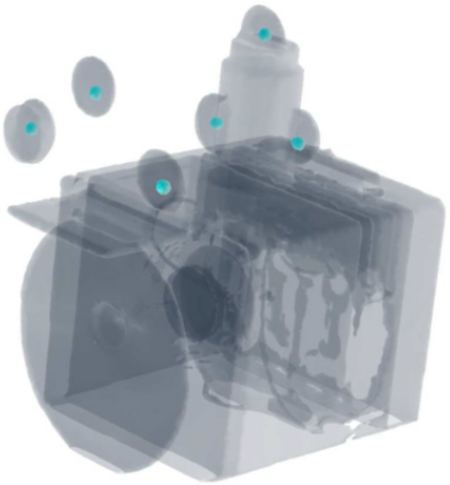

Figure 2c 50% phase image.

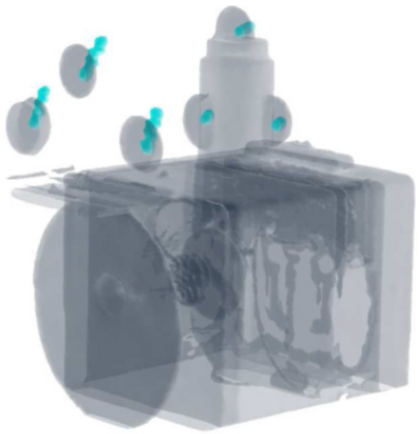

Figure 2d Maximum intensity projection image.

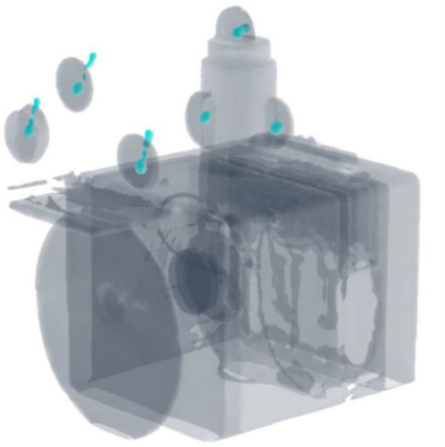

Figure 2e Average IP image.

Furthermore, our study also included shape variation for small targets moving in different directions and localization of target in different directions.

Results

At 350 HU window width and 40HU window level, image sets from helical scan for the static phantom is used as reference, comparing to helical scan from moving phantom, retrospective MIP,

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average intensity projection, 0% phase and 50% phase, for pellets moving at 0.4 cm per second, the average coordinate deviation are 0.49cm, 0.22cm, 0.19cm, 0.59cm and 0.06cm with standard deviation 0.83cm, 0.29cm, 0.32cm, 0.69cm, and 0.07cm, the percentage distance differences are 10.2%, 3.3%, 7.3%, 0.1%, and 0.1% with standard deviation of 13.2%, 4.4%, 9.6%, 0.1%, and 0.1%. And the percentage volumes changes are 17.4%, 171.5%, 18.4%, 14.2% and 7.8% with standard deviation at 25.4%, 201.8%, 23.7%, 19.85% and 10%. Figure 3 illustrates these results in single diagram, which include target center positions, distances between target center, and volume variation at this simulation mode.

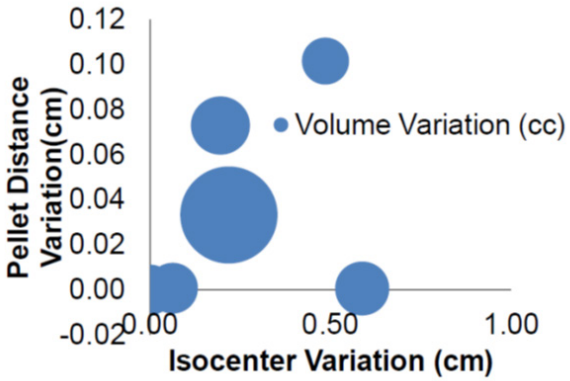

Figure 3 Multiple dimensional variable distribution for target moving at same trajectory.

Our study also included imaging information of the small target moving in different directions and localization of target in different directions. Only circle motion trajectory was analyzed in current study. This motion in both 4DCT imaging and CBCT imaging was compared. Figure 4a and 4b show 4DCT MIP image and CBCT image for small target moving at circle trajectory.

Figure 4a Target in 4DCT.

Figure 4b CBCT image.

Discussions and conclusion

A simple and sensitive 4DCT quality assurance method was developed by combining Varian RPM phantom and CT-spot pellets from Beekley Medical and it shows that the 50% phase image set is better for SBRT Planning and the margin of target should refer to MIP image.

For further trajectory study, there are x-trajectory, y-trajectory, xy-trajectory, even speed, irregular speed, and so on. With the availability of some special designed analogy patient information, the tumor target could be understood better in small physical scale.

Clinically, with applying this RMP phantom study methodology, the comparison of free breathing, gated delivery and breath-hold delivery, their corresponding dosimetry could be further understood. The dose delivery accuracy is also determined by registration between simulation CT image and CBCT image for currently SBRT practice. The discovery of the optimal registration result could be some hints for improvement of clinical outcome.

In imaging diagnostic aspect, the accurate level of dosimetry could be analyzed through inhomogeneity similarity match to real patient target, and high precise dose control could be possible given sufficient research in HU unit threshold selection standards.

As conclusion, in this study, a simple and sensitive 4DCT quality assurance method was developed by combining Varian RPM phantom and CT-spot pellets from Beekley Medical and it can be applied in procedure simulation of motion target in different imaging modes in a typical radiotherapy department with limited resource availability.

Conflicts of interest

None.

Acknowledgements

None.

References

1. Keall PJ, Mageras GS, Balter JM, et al. The management of respiratory motion in radiation oncology report of AAPM Task Group 76. *Med Phys.* 2006;33(10):3874-3900.
2. Stroom J, Blaauwgeers H, Van Baardwijk A, et al. Feasibility of pathology-correlated lung imaging for accurate target definition of lung tumors. *Int J Radiat Oncol Biol Phys.* 2007;69(1):267–275.
3. Nehmeh SA, Erdi YE, Pan T, et al. Four-dimensional (4D) PET/CT imaging of the thorax. *Med Phys*. 2004;31(12):3179-3186.
4. Cai J, Chang Z, Wang Z, et al. Four-dimensional magnetic resonance imaging (4D-MRI) using image-based respiratory surrogate: A feasibility study. *Med Phys.* 2011;38(12):6384-6394.
5. Villanueva-Meyer JE, Mabray MC, Cha S. Current clinical brain tumor imaging. *Neurosurgery.* 2017;81(3):397-415.
6. Del Sole A, Moncayo R, Tafuni G, et al. Position of nuclear medicine techniques in the diagnostic work-up of brain tumors. *Q J Nucl Med Mol Imaging.* 2004;48:76-81.

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