Ideal Computed Tomography Dataset for Stereotactic Ablative Radiation Therapy (SABR) Planning in Lung Cancer

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BACKGROUND

Stereotactic Ablative Radiation Therapy (SABR) is an alternative to surgery in patients with lung cancer that are medically inoperable or refuse surgery. This technique is a noninvasive therapeutic modality where high doses of radiation are administered in a small volume of treatment and in a reduced number of fractions. The lower the irradiated volume, the lower will be the dose received by adjacent organs at risk (OAR). To achieve this reduced volume, a high precision in the identification of the lesion and its movement during breathing is necessary. Respiratory motion is a challenge in radiation therapy due to geometrical uncertainties of both the target and normal organs. The step that precedes the treatment is called planning and begins with the acquisition of images by computed tomography (CT). For the planning of SABR for lung cancer, patients undergo a four-dimensional CT (4DCT). This procedure is essential to evaluate the movement that occurs in the tumor and in the adjacent organs due to respiratory motion.

Currently, the SABR protocol at the *Instituto Nacional de Câncer* (INCa) includes the acquisition of the images in 2 steps: first, a free breathing CT (FBCT) and after that, the 4DCT. The 4DCT takes into account the patient's respiratory cycle unlike FBCT. The images generated by the 4DCT are sorted according to the phase of the respiratory cycle. After this sorting process, two reconstructions are performed. The reconstruction showing the maximum projection intensity of the lesion and the OAR is known as MIP and is used to identify the target volume to be treated. The reconstruction that shows the average projection of the lesion and organs at risk during the respiratory cycle is called AIP or AVG. When performing 2 procedures at the same time, a fusion of images is performed (co-registered) automatically by the system planning. So, 4DCT is used to identify the lesion and its movement and FBCT is used to identify/contour the OAR and also to calculate the dose. Therefore, despite of using the 4DCT, the planning/calculation of the dose is in 3 dimensions (3D). Some studies show that when a 4DCT is performed, reconstruction in AVG can replace FBCT to contour OAR without significant difference between the 2 techniques. These studies therefore suggest that AVG is equivalent to FBCT.

The RTOG and ASTRO protocols for SABR in lung cancer recommend the use of heterogeneity correction in the calculation of radiation dose. However, there is no recommendation of which CT scan dataset should be used for treatment planning. The difference in Hounsfield units (HU) between CT imaging datasets could theoretically lead to variation in dose coverage in the tumor during planning optimization by the planning system.

Lung SABR requires that the patient stay immobilized in a support with raised arms. Often, this position is uncomfortable or painful for patients, who are generally fragile or elderly.

It is important to analyze the institutional data to define the most appropriate protocol for our reality, once there is no consensus in the RTOG or ASTRO guidelines. The acquisition of images for planning with 2 procedures is more time consuming and generates more dose of radiation in the patient compared to the acquisition of the TC4D only.

PURPOSES

The use of FBCT combined with TC4D is the standard in current treatment planning. If FBCT and 4DCT are equivalent for planning, it will be possible to use only the 4DCT for this. Performing only the 4DCT would reduce costs, radiation dose, patient time in the equipment and would be more comfortable for the patient. In addition, the linear accelerator would be occupied for less time, generating cost reduction and optimization of the use of the equipment. The aim of the present study is to compare the parameters generated by the FBCT with those of the AIP reconstruction of the 4DCT and to define the best protocol to be used for the SABR planning in our institution. Some referral centers have already stopped performing the FBCT for planning and this is done using only the 4DCT.

METHODS

All patients submitted to SABR for lung cancer at the institution between 2013 and 2018 will be included in the study. The data of the treatment plans generated by the radiotherapy planning system (Eclipse® version 13.6; Varian Medical Systems, Palo Alto, CA, USA) from these patients will be analyzed retrospectively. The volumes of OAR generated by each acquisition will also be evaluated to determine if there is equivalence between the methods for contouring and calculating the dose.

The treatments are performed with Volumetric Arc Therapy (RapidArc®). For each patient, the plane obtained in 3D with the plane obtained in 4D will be compared. For this, the dosimetric parameters commonly used in the evaluation of radiotherapy planning will be evaluated. All parameters will be compared and analyzed using a Wilcoxon test.

RESULTS

The study is ongoing and the data are been analyzed.

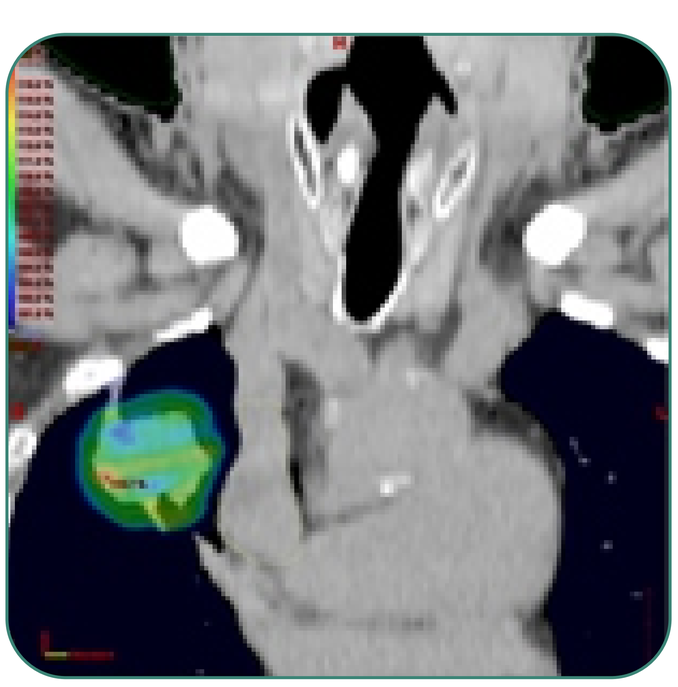

Fig. 1: SBRT for a non-small cell lung cancer

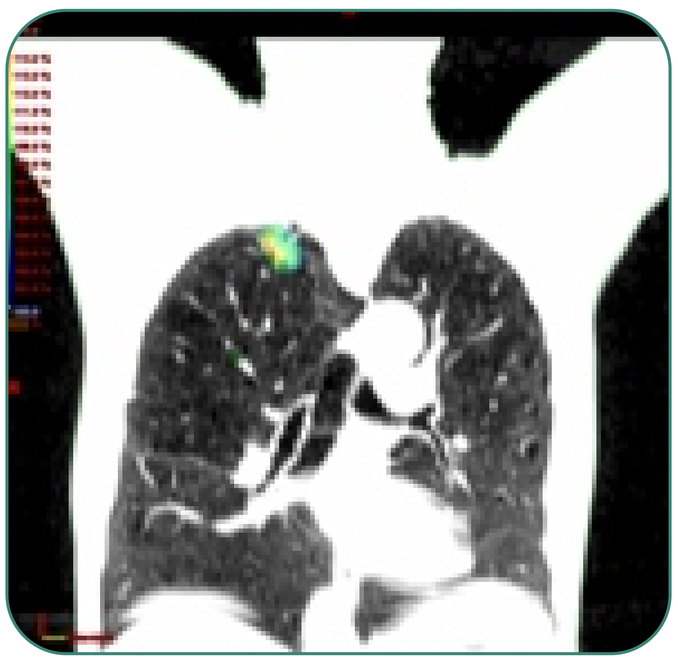

Fig. 2: SBRT for a non-small cell lung cancer

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