Title: Study of the feasibility of the implementation of VMAT stereotactic radiotherapy for pulmonary sites.

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Introduction:

The objective of this study is to investigate the feasibility of using the VMAT treatment technique during pulmonary stereotactic treatment. The related perturbations caused by the movements come from two sources, the dose gradient or the dose blur and the interplay effect. These two effects will be studied in order to determine their impact on the dose distribution according to the amplitude of the movement and their consequences on the realization of treatments in free-breathing.

Methods:

The study was performed retrospectively for 14 patients treated in stereotactic conditions by coplanar fixed fields. All patients benefited from a 4D scanner acquisition to obtain 3D series images on 10 respiratory phases [0-90%], and of an the average 3D image series (AVE). The tumor volumes and amplitudes were [22,8 ± 18,1] cm^3 and [8,5 ± 8,2] mm. Dosimetric's plan of each patient was performed on the Eclipse TPS with the Acuros V.11 algorithm and a 1 mm calculation grid on the AVE 3D image series. These planes have been optimized for ballistics of two half-arcs, collimator at 45°, and a hypo-fractionation of 5*10 Gy. The set has been validated by a medical physicist and radiotherapist. Then, each scheduling was carried over to the AVE series of heterogeneous Cheese phantom (Gammex) acquired in 4D thanks to a dynamic CIRS platform (Model 008) reproducing the patient's respiratory signals. For each patient, 6 measurements per Gafchromic EBT3 film were made on a Novalis Truebeam STX (Varian, Brainlab) in the Cheese phantom placed on the dynamic platform: 1 reference film per half-arc without movement, 1 film per half-arcs, starting the irradiation at the phase 0% of the respiratory signal of the patient and 1 film by half arcs starting the irradiation at the phase 50% of the patient's respiratory signal. The RIT software was used to compare films to each other and to the TPS dose calculations to determine the interplay effect and the dose gradient effect, respectively.

Results:

For the amplitudes and respiratory periods of the 14 patients, the interplay effect is negligible because the differences are small between the films acquired by starting at the 0% phase and those acquired at the 50% phase with an average gamma index of 98.9 ± 1.8 % in 2%/2 mm. On contrary, the dose gradient effect (comparison TPS vs Film at 0% and 50%) can be seen from 6.5 mm amplitude with a mean gamma index of 3%/3mm passing from 99.5 ± 0.7 % for the amplitudes from 0 to 6.5 mm to 87.2 ± 10.9 % for the amplitudes from 6.5 to 10 mm. The gamma index of 2%/2mm increases from 94.0 ± 4.9 % to 74.2 ± 13.4 %.

Conclusions:

This study on the feasibility of the implementation of pulmonary stereotaxic in VMAT shows that it is possible to treat a patient in free-breathing up to 6mm of motion amplitude. From this limit, it is necessary to proceed under the control of a respiratory affection system. Moreover, the interplay effect does not affect distribution's dose and only the effect of the dose gradient is visible for these configurations.