**Title:** Dosimetric and radiobiological evaluation for the clinical validation of Acuros XB algorithm in thoracic radiation therapy

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**Introduction:** Acuros-XB (AXB) algorithm has been introduced several years ago in order to improve the accuracy of dose calculation in radiotherapy, especially in the presence of tissue heterogeneities. This type (c) algorithm is based on the deterministic resolution of the linear Boltzmann transport equation and offers results close to Monte Carlo simulations.

This study aims to evaluate the clinical impact of a new algorithm by comparing the dosimetric and radiobiological results of the AXB algorithm for its two reporting modes (dose to water AXB-Dw and dose to medium AXB-Dm), compared to a reference algorithm: the Anisotropic Analytical Algorithm (AAA).

**Methods:** Ten cases of patients treated for lung cancer with conformational radiotherapy were studied. For each patient, five treatment plans were generated. The dose in plans 1, 2 and 3 was respectively calculated with AAA, AXB(Dm) and AXB(Dw), using the same prescribed dose (PD). In plans 4 and 5, the dose was calculated using the two AXB calculation modes with the same number of monitor units (MU) derived from the AAA calculation (plan 1). The dosimetric evaluation was based on the comparison of dose volume histograms (HDV) and quality metrics (i.e. Conformity, Coverage and Homogeneity indices). Radiobiological assessment was based on the comparison of tumor control probabilities (TCP) and toxicity probabilities (NTCP) for organs at risk (OARs), including lungs, esophagus and heart. Wilcoxon and Spearman’s rank tests were used to calculate p-values and the correlation coefficient (ρ).

**Results:** Using the same PD, we observed a significant increase in the number of MU (1%-4%), depending on the choice of AXB-Dm or AXB-Dw. In dosimetric terms, dose calculated with AXB is more heterogeneous. This introduces a significant decrease in the minimum dose to the PTV and in the quality indices. These elements can influence the therapeutic results. In addition, the dose to OARs was increased from +2% to + 10%. The increase in dose to target volumes and OARs with AXB, using the same PD, explains the increase in TCP (+1% to 2%) and in NTCP (+2%) (p <0.01).

**Conclusions:** AXB algorithm is known to provide improved calculation accuracy. However, a special attention is required in order to safely implement its clinical use. Depending on the medium density, the technique and the treatment field size, MU can increase as well as the dosimetric values and the NTCPs. Radiation oncologists and medical physicists should define together the attitude to be adopted regarding these dosimetric shifts. A reasonable approach would be to keep the same PD while increasing the sparing of the OARs.