**A multicentre QA study on 4DCT and IMRT/VMAT techniques for lung stereotactic treatments using the 008A CIRS 4D phantom**

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**Introduction**: To determine stereotactic treatments accuracy in the institutions participating in the Phase II EORTC trial: Lungtech, we have performed end-to-end tests investigating both 4D computed tomography (4D-CT) and IMRT/VMAT technique under static and dynamic conditions.

**Methods**: All centres audited (6) performed 3D-CTs and 4D-CTs on the same CIRS008A phantom. The phantom was successively scanned using two film inserts, one with a 15mm diameter target (15mmd) and the other carrying a 25mm diameter target (25mmd). Three motions were tested: 20bpm/15mm amplitude (A), 10bpm/15mmA, and 15bpm/25mmA. We thus developed a  test procedure to evaluate the impact of motion on the target volume and motion as determined using the available binned CT data. These results were evaluated and compared to the true volume and the known motion amplitude. Regarding the credentialing of radiotherapy delivery, three treatment plans were made by institutions based on the two targets static 3D-CTs and using the 4D-CT data set of the 15mmd animated by the 20bpm/15A signal. Prior to phantom measurements, a beam output check was performed in water under reference conditions for the institution chosen energy. The plans were then measured twice using EBT3 films (12,5cmx5 cm) and a 0.04cc ionization chamber (Scanditronix/Wellhoffer Inc.). The films analysis was done in RIT113 version 6.3. Gamma analyses were performed using film dose as reference, a normalisation at the centre of the sphere, a dose threshold at 20%Dmax and 3% dose /3mm deviation as agreement criteria. **Results**: On average volume deviations (here expressed in % of the true volume) were respectively for the 15mmd and the three motions tested: +10%(+/- 7%), + 1% (+/-17%), +12%(+/-12%) and for the 25mmd: +6%(+/-7%), +4%(+/-7%)\*.[[1]](#endnote-1) Volume deviations were found higher at the end of inspiration than at the end of expiration 8% (+/-26%) insp and 1% (+/-3%) exp. The range of motion was underestimated in all cases of in average -0,15cm (+/- 0,07cm), the slow breathing pattern (10bbpm) presented the largest mean error -0,2cm(+/- 0,2cm) compared to the breathing pattern 20bpm/15A, -0.09cm(+/- 0,08cm). Regarding the dosimetric evaluation, the output dose mean deviation was 0.57% (+/- 1.42%) across institutions, agreement between chamber doses and point-planned doses were respectively for the 15mmd and the 25mmd static 98.9%(+/-1.3%), and 99.9%(+/-2.8%). Agreement with planned dose (centre of the PTV taken as reference point) for the 15mmd in motion was 98.6% (+/- 0.86%). The film gamma mean pass rates were 70% for 15mmd static, 59% for 15mmd dynamic and 74% for 25mmd static.

**Conclusion**: QA of stereotactic treatments on a moving target are not yet practice routine, film dosimetry in 4D conditions can be challenging due to the absence of a consortium on where the films should be registered to the planned dose. Moreover we lack of consistent data to define an acceptability threshold. These preliminary results are a starting point for discussion, with more dataset analysed we hope to correlate 4DCT and dosimetric data and to propose relevant evaluation criteria.

  

**a b c**

Fig.1. Average 4D-CT with the 15mmd target surrounded by the three registration markers (a:axial,b: sagittal, c: coronal, planes)

1. 15bpm/25mmA not tested on the 25mmd insert. [↑](#endnote-ref-1)