Impact of Contouring Variability on Tumour Control and Normal Tissue Toxicity in Liver Stereotactic Body Radiotherapy

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Purpose
Variability in the contouring of gross tumour volume (GTV) and the derived planning target volume (PTV) between clinicians is well-known in radiotherapy. This study aims to quantify the impact of variability in contouring in terms of tumour control and normal tissue toxicity in Liver Stereotactic Body Radiotherapy (SBRT).

Conclusion
Significant variability exists in contours drawn by different centers/clinicians in the setting of pre-trial QA to the extent where 10% or more of the PTV receives a BED insufficient for local control in a proportion of cases and NTCP is significantly affected. Given this variability, the pre-trial and on-trial RTTQA process is essential if the effect of contour variability on tumour control rates and treatment toxicity is to be mitigated.

Methods and Materials
The UK National Radiotherapy Trials Quality Assurance (RTTQA) Group planning benchmark case for the ABC07 Trial was used (addition of stereotactic body radiotherapy to systemic chemotherapy in locally advanced biliary tract cancers; CRUK A18752, sponsor University College London). 12 centers performed contouring independently using radiotherapy trial protocol as per RTTQA pre-trial QA process. A 4mm GTV-PTV margin was applied. Conformity analysis was performed relative to CI PTV and STAPLE algorithm consensus.

Jaccard coefficient = \( \frac{A \cap B}{A \cup B} \)

Dice coefficient = \( \frac{2 \times (A \cap B)}{A + B} \)

Geographical miss index = \( \frac{B - (A \cup B)}{A} \)

Discordance index = \( 1 - \frac{A}{\text{Baseline}} \)

A standardised Volumetric Modulated Arc Therapy (VMAT) plan was produced based on ABC07 Chief Investigator (CI) contours and applied to all 12 sets of submitted contours aiming to deliver 50Gy in 5 fractions. However, due to large GTV this was unavoidably de-escalated to 40Gy to meet trial mandatory mean non-GTV Liver constraint. Tumour control was assessed through biologically effective dose (BED) to 98, 95 and 90% of the gold standard PTV (CI PTV). 65Gy BED, although disappointingly low for SBRT, was considered as a cut off for acceptable therapeutic intent. NTCP modeling of radiation induced Liver disease was also performed.

Figure One: A. general consistency in GTV contouring. B. inconsistency surrounding vessels. C. schema of planning target volume (PTV) strategies. D. inconsistency in ITV 4DCT based contouring.

Figure Two: (left) Jaccard and Dice indices (right) Geographical Miss and Discordance for PTV relative to that defined by trial Chief Investigator and expectation-maximization (EM) algorithm for simultaneous truth and performance level estimation (STAPLE).

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