Evaluating automated contour propagation for estimating tumour shrinkage in small-cell lung cancer patients treated with chemo-radiotherapy

A McWilliam[1,2], A Green[1], J Khalifa[3], T Merchant[2], N O'Conner[4], C Faivre-Finn[1,2], M van Herk[1,2]

1 Division of Clinical Cancer Science, Faculty of Biology, Medicine and Health, The University of Manchester, UK; 2 The Christie NHS Foundation Trust, Manchester; 3 Department of Radiation Oncology, Institut Universitaire du Cancer de Toulouse; 4 Elekta Maryland Heights

Introduction

The clinical relevance of tumour shrinkage during thoracic radiotherapy remains unknown with studies showing conflicting results whether shrinkage predicts outcome. Previous work has relied on manual contouring on cone beam CT (CBCT). To enable large scale analysis, automated methods for contour propagation and quantification of tumour shrinkage are essential.

Method

- 20 small-cell lung cancer patients treated with chemo-radiotherapy
- Manual contouring of the GTV on all CBCTs
- Automatic propagation of the GTV was performed (ADMIRE, Research v1.13, Elekta AB, Stockholm, Sweden). **(Figure 1)**
- Median Distance to Agreement (mDTA) was calculated between contours to assess accuracy
- Differences in volumes (manual versus automatic) were assessed using a Bland-Altman plot **(Figure 2)**
- Relative percentage change was calculated at each time-point and fitted using linear regression to assess shrinkage **(Figure 3, 4)**

Results

ADMIRE successfully propagated GTV contours across all CBCTs. Concordance between the manual and propagated contours showed an **unsigned mDTA of 3mm across all CBCT.** Results were worse for GTV contours overlapping with the mediastinum

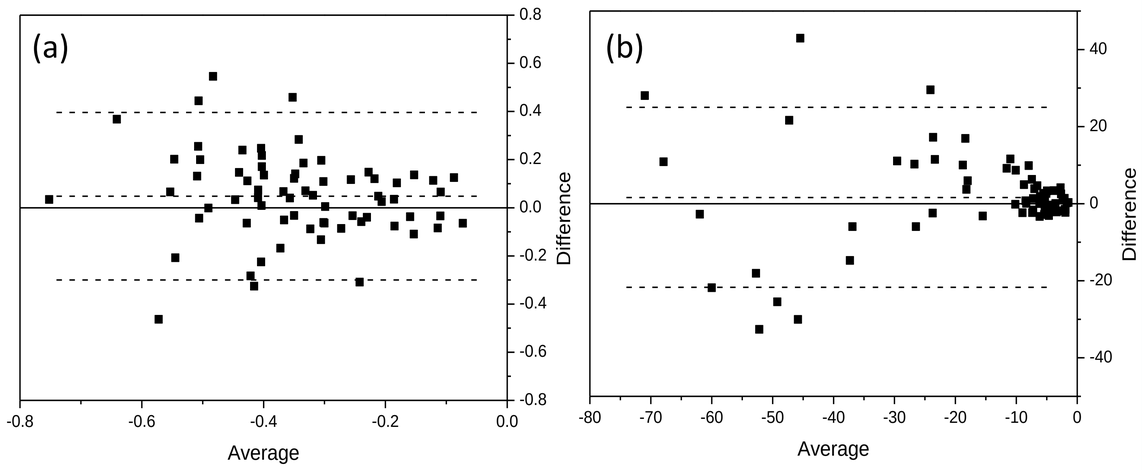


Figure 2. (a) The Bland-Altman analysis for absolute differences in volume at each time-point resulted a mean of -1.6cm³, 95% confidence intervals 25.0cm³ to -21.7cm³. (b) Relative differences provided a mean of -4.8%, 95% confidence intervals 39.6%, to -30%. Manual contours showing smaller volumes.

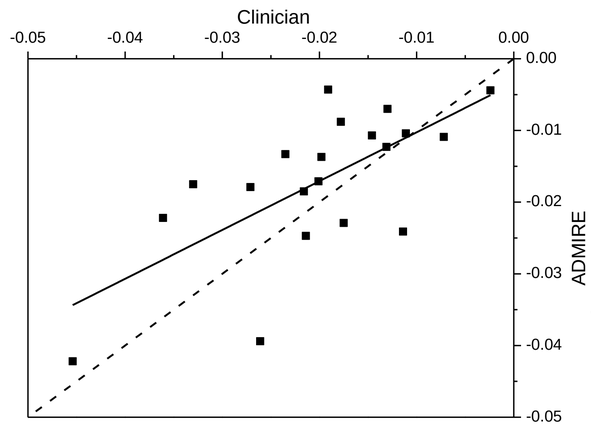


Figure 3. The relative slope of the tumour volume changes is plotted for each patient with the manual contours and the automatic contours. If both were in perfect agreement the dashed line would be found. Overall, manual contours show a greater degree of volume reduction than automatic contours.

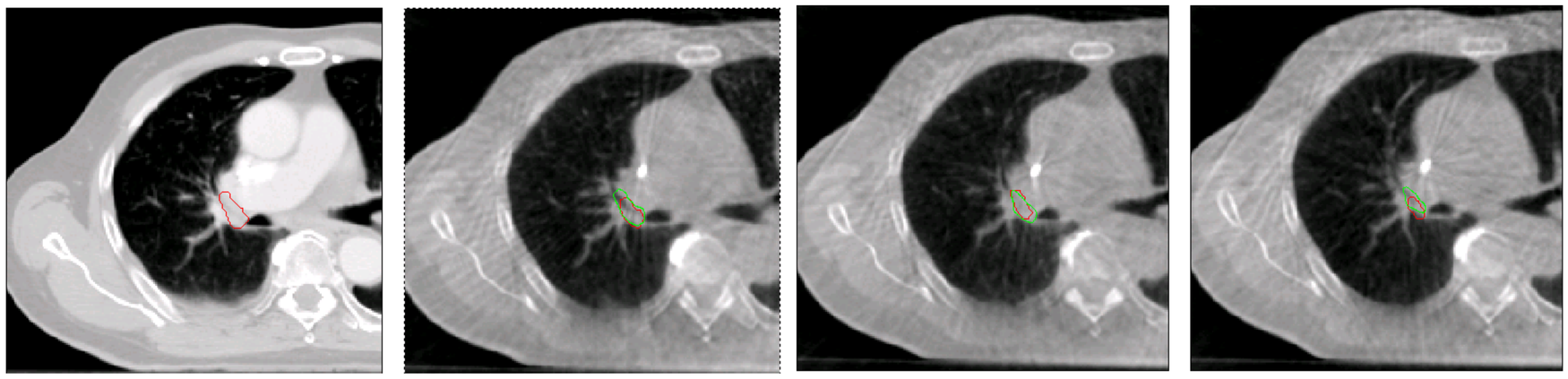
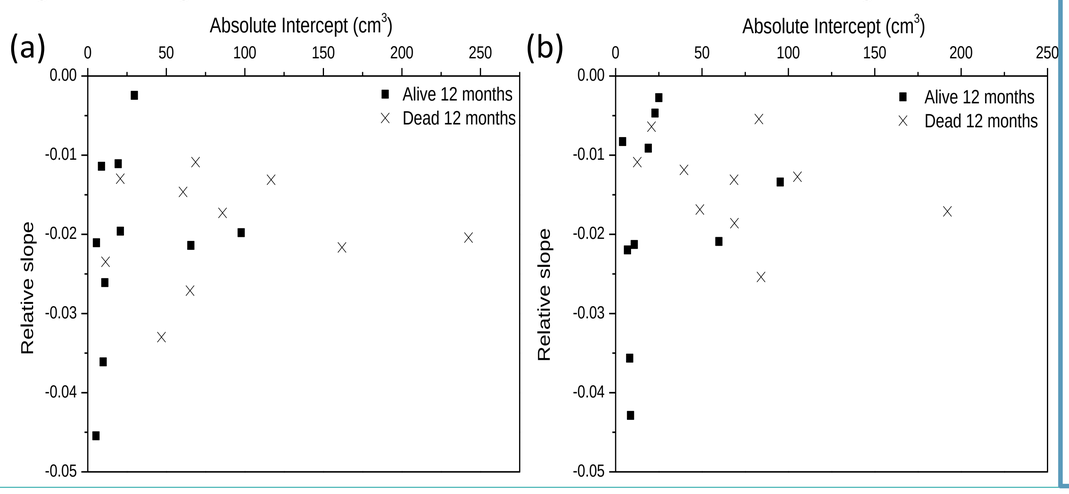


Figure 1. The contouring for one patient is shown, including the planning CT and CBCT from three timepoints in treatment. The manual contours are shown in red and the automatic contour in green. The overlap in contours can be seen, although there is some disagreement. The relative decrease in tumour volume, compared to day one of treatment is also included. It can be seen that the manual contouring showed a greater reduction in volume that the automatic contouring.

Figure 4. Plots of the relative slope versus the initial tumour volume on day one CBCT (absolute intercept of the linear fit). Patients dead and alive at 12 month are labelled. (a) the manual contours and (b) the automatic contours. A simple model based on these two values can be created that produces the same sensitivity and specificity for the manual and automatic contours in predicating survival at 12 months.



Conclusion

The results show that automatic contour propagation performance is acceptable for use in wider research studies. There are differences between the manual and propagated contours, with the clinician estimated a larger rate of tumour shrinkage, which is suggestive of an observer bias. We will now apply this technique to investigate tumour shrinkage and outcome in the CONVERT trial patients.