Facilitating the MidVentilation SABR Lung Technique with deformable image registration: Retrospective Study into contour accuracy

Johnson Yuen[1]
Kendell Shields-Dowton[1], Joel Poder[2], Andrew Howie[3], Yaw Chin[1], Ewa Aren[1], Laurel Schmidt[1], Angela Rezo[4], Jonathon Lee[4], Eric Hau[5], Jeffrey Barber[6], Shrikant Deshpande[7] and Lois Holloway[8]
[1] Cancer Care Centre, St. George Hospital
[2] St George Hospital Cancer Care Centre
[3] South Eastern Sydney Local Health District
[4] Canberra Hospital, Canberra
[5] Sydney West Radiation Oncology, Westmead and Blacktown Hospitals
[6] Sydney West Radiation Oncology Network
[7] Liverpool Hospital
[8] South Western Sydney Clinical Campus, School of Clinical Medicine, University of New South Wales, NSW, Australia; South Western Sydney Cancer Services, NSW Health, Sydney, NSW, Australia; Ingham Institute for Applied Medical Research, Liverpool, NSW, Australia.

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[1] Cancer Care Centre, St. George Hospital, NSW, Australia

[2] South Western Clinical School, University of New South Wales, Sydney, Australia

[3] Ingham Institute for Applied Medical Research, Sydney, Australia

[4] Centre for Medical Radiation Physics, University of Wollongong, New South Wales, Australia

[5] School of Physics, University of Sydney, Camperdown, New South Wales, Australia

[6] St George & Sutherland Clinical School, University of New South Wales, New South Wales, Australia

[7] Canberra Hospital, Canberra, ACT, Australia

[8] Sydney West Radiation Oncology, Westmead and Blacktown Hospitals

[9] Westmead Clinical School, The University of Sydney

[10] Westmead Institute of Medical Research, Sydney

[11] Radiation Oncology Network, Western Sydney Local Health District, NSW, Australia

[12] Institute of Medical Physics, University of Sydney, NSW, Australia

[13] Liverpool and Macarthur Cancer therapy centre, Liverpool Hospital NSW 2170

Aims

For lung tumour radiotherapy, the internal target volume (ITV) technique is most used in Australia[1]. The MidVentilation (MidV) technique[2] is an alternative to ITV that offers high rates of local control[3] with reduced planning target volume (PTV)[4]. Despite these benefits, the MidV technique is more complex, requiring efficient[5] and accurate[6] 4DCT contouring. Our department implemented an Eclipse-based deformable image registration (DIR) method for 4D GTV contouring. This study aims to evaluate the accuracy of 4D DIR contouring methods for the MidV technique.

Methods

Existing 4DCT datasets with 4D manual GTV contours from 28 patients, obtained from a retrospective MidV sub-study conducted across 3 departments were used. This sub-study was based on the multi-centre Phase II study for small cell lung cancer non-small cell lung cancer (SBROC 002)[7].

Additional data was generated to support the study: (i) expert GTV contours on each 4DCT phase by the lead Radiation Oncologist (RO) as ground truth, assisted by 4D Eclipse DIR with manual editing; (ii) 4D contours were produced with Velocity[8]/MIM[9]/Eclipse[10] DIR from from either the 0% or 20% phase; (iii) Eclipse was used to determine the MidV phase for each contouring method, with the GTV on this phase defined as MidV GTV; (iv) a MIM workflow was used to generate contouring metrics[11], including mean distance to agreement (MDA); (v) statistical analysis and plots using Excel and R.

Results

Figure 1 shows MidV GTV contour accuracy with MDA, with reference to manual ground truth contour. 4D DIR methods are more consistent with the ground truth than inter-observer variation (mean <2mm), and within AAPM TG132 guidelines[12]. 4D DIR with 20% phase (mean <1 mm) showed less variation than the 0% phase.

Conclusions

In the context of 4D contouring for MidV, 4D DIR with GTV starting on 20% phase showed most consistency and was clinically acceptable.

Figures

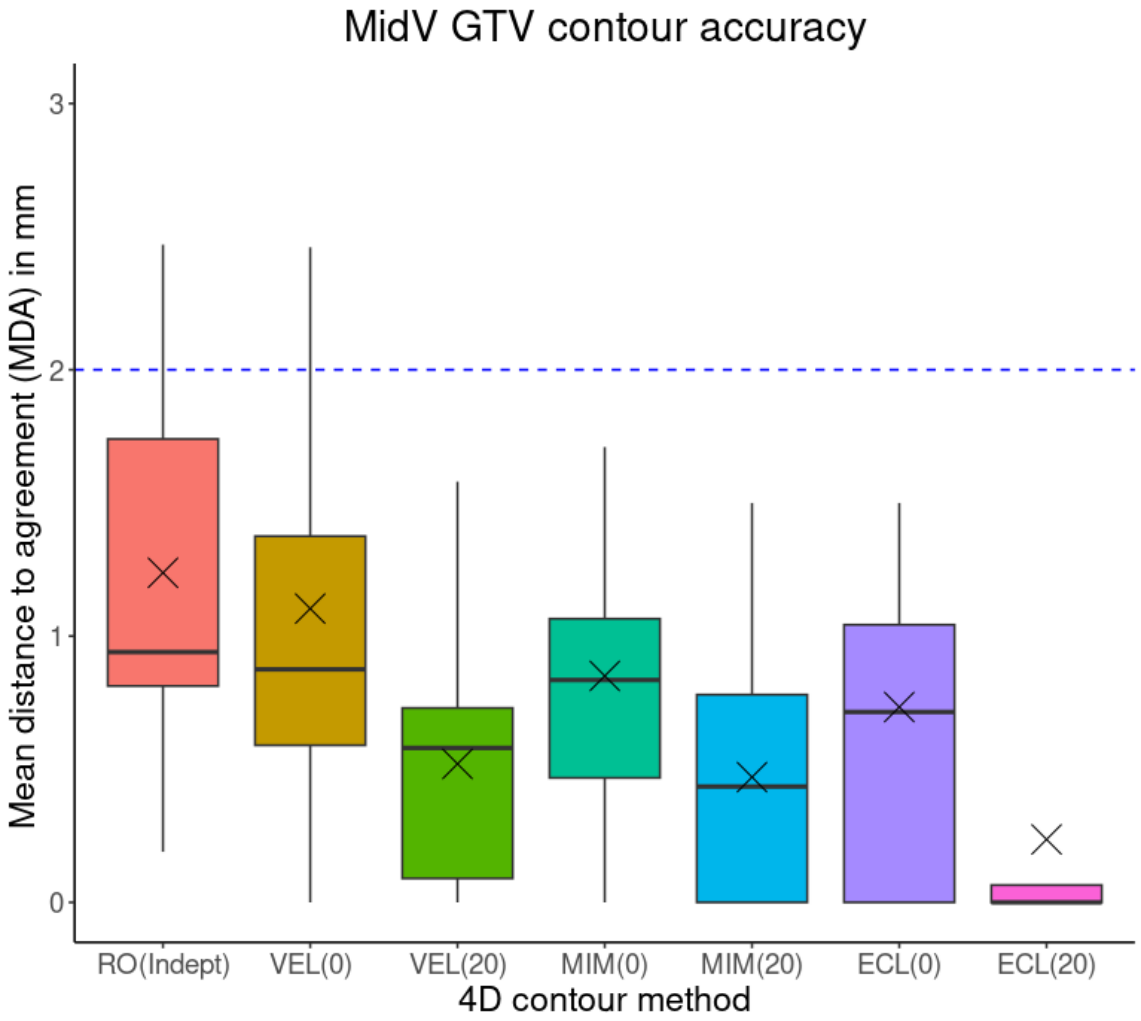

Figure 1: Whisker and box plot of each 4D DIR contouring methods with reference to manual ground truth MidV GTV, with y axis as mean distance to agreement (MDA) in mm, over 28 patients. The methods include an independent second RO observer "RO(Indept)", Velocity 4D DIR starting with 0% phase "VEL(0)" or 20% phase "VEL(20)", MIM 4D DIR starting with 0% phase "MIM(0)" or 20% phase "MIM(20)", and Eclipse 4D DIR starting with 0% phase "ECL(0)" or 20% phase "ECL(20)"; the whisker and box plot has the box that represents the middle 50% of the data, the upper portion of the box as upper quartile (75%), the lower portion of the box as lower quartile (25%), the median as the line within the box, the mean as the "x" in the box, whiskers indicating minimum and maximum data; blue dotted line represents 2 mm MDA, indicating an acceptable tolerance for contour agreement

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