Title: Metabolic tumour volume segmentation for oesophageal cancer on hybrid PET/CT using convolutional network architecture.

Topic: D25 Artificial Intelligence

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Authors Disclosures:

I or one of my co-authors hold a position as an employee, consultant, assessor, or advisor for a pharmaceutical, device or biotechnology company.

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> Nothing to declare.

I or one of my co-authors have written articles for (radio)pharmaceutical, med. device, biotechnology, or consulting companies during the last 5 yrs.

> Nothing to declare.

Introduction

Oesophageal cancer (OC) has a particularly poor prognosis with an overall 5-year survival rate of only 15%. OC is rising in incidence and is a cancer with unmet clinical need. The segmentation of metabolic tumour volume (MTV) is time consuming and subject to intra and inter-observer variability. This study aims to increase the efficiency of MTV segmentation in OC by developing a hybrid PET/CT deep-learned model based on convolutional network architecture.

Materials and Methods

A data set of 440 patients with biopsy-proven OC tumours was included in this study. All patients had PET/CT acquisition using a GE 690 scanner with time of flight. Details of patient selection and image acquisition parameters were published by our group [1,2,3].
Only primary tumours were used in this study for the development of a deep-learning model. The primary MTV was delineated on PET imaging using a previously published segmentation method[4,5] and reviewed by a consultant radiologist.

For the convolutional network architecture, we used a 2-dimensional (2D) based U-Net architecture[6]. The developed model was trained using a cluster consisting of 2 nodes. Each node contained 2 CPU's running at 2.10Ghz, resulting in total of 88 threads per node.

Contours delineated with the proposed deep-learned model were assessed using a Turing test including a total 376 images with associated contours for evaluation by 5 independent radiologists (Ob1 – Ob5).

Results

The mean Dice Similarity Coefficient (DSC) of the U-net architecture, when compared to manual outlines, was 0.73. In the Turing test, Ob1 to Ob5 had accuracies of 0.55, 0.73, 0.47, 0.64 and 0.46, respectively. Sensitivity for Ob1 to Ob5 was 0.66, 0.64, 0.38, 0.56, and 0.47 respectively. Specificity for Ob1 to Ob5 was 0.44, 0.83, 0.57, 0.71, 0.46. The area under the curve values ranged from 0.46 to 0.73.

Conclusion

We successfully trained a convolutional network to segment the metabolic tumour volume on hybrid PET/CT oesophageal cancer. The performance of the network was confirmed to be equivalent to expert delineation.

References

1. Foley, K.G. et al., 2018. Eur. Radiol. 28, 428–436.
2. Foley, K.G., et al. 2019. Radiother. Oncol. 133, 205–212.
3. Parkinson, C., et al 2018. EJNMMI Res. 8-29.
4. Berthon, B., et al. 2017. Radiother. Oncol. 122, 242–247.
5. Berthon, B. et al 2016. Phys. Med. Biol. 61, 4855–4869.
6. Ronneberger, O. et al 2015. Lect. Notes Comput. Sci. 9351, 234–241.