Correlation of pre-operative cancer imaging techniques with post-operative macro and microscopic lung pathology images

S. HARROW (1) G. REINES-MARCH (2) C. DICK (3) X. JU (3) S. MARSHALL (2)

(1) BEATSON WEST OF SCOTLAND CANCER CENTRE (2) UNIVERSITY OF STRATHCLYDE (3) NHS GREATER GLASGOW AND CLYDE

Background: This research project aims to investigate the performance of several PET radiotracers in lung cancer by aligning PET-CT and pathology imagery acquired from the same patients at different points in time. The discrimination of tumour substructures is of great importance in therapy planning, as a given treatment may be better adapted depending on the local characteristics of the carcinoma.

Method: Due to the high deformability of lung tissue, several intermediate steps must be used for merging pathology and pre-operative PET-CT in a coherent manner. Firstly, the tumour volume is reconstructed from the macroscopic images taken during dissection. For this purpose, an enhanced dissection protocol is used, where the lung specimen is placed in a bespoke slicing rig and embedded in agar to hold it in place. Using a threaded plunger, the specimen is pushed upwards in 5mm steps, sliced and photographed. This procedure allows us to obtain slices of uniform thickness. Secondly, microscopic digital slides of the cancerous tissue are merged with the macroscopic 3D model. Finally, the whole volume is fused with the preoperative PET-CT scan, using a non-linear deformable model.

Result: Preliminary results obtained with a synthetic phantom allowed us to analyse the accuracy of the tumour 3D reconstruction algorithm from planar macroscopic slices. Using these findings, we could optimise the interpolation and segmentation routines for building an accurate 3D model of the tumour mass. During our first trial with lung tissue (ongoing work), each cross-sectional slice was photographed, the tumour boundary was delineated in each image by a pathologist (CD), and from these contours a high-resolution 3D tumour model was built. Next, the corresponding microscopic digitised slices were merged. To date, ten patients have been identified and consented, therefore allowing us to test our algorithm on different cases and assess its performance.

Conclusion: We demonstrate a novel set of methods for co-registration of preoperative PET-CT to macro and microscopically defined lung tumours. This proof of principle now allows interrogation of the raw data from PET-CTs using a range of tracers and the development of algorithms that identify substructure detail within a tumour mass, which could lead to tailored radiotherapy for individual tumours based on tracer patterns and uptake.

Keywords: pathology, co-registration, functional imaging