Impact of Registered Positron Emission Tomography Data on Radiotherapy Planning for Oesophageal Cancer

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Purpose

Positron Emission Tomography (PET) has played an increasing role in tumour delineation for oesophageal cancer radiotherapy planning. A systematic review showed the use of $^{18}$F-Fluorodeoxyglucose (FDG)-PET resulted in target volume changes compared to CT alone [1]. We aimed to assess the impact of FDG-PET CT on target volume delineation and radiotherapy planning parameters for patients treated with radical radiotherapy for oesophageal cancer. We previously reported no significant differences in GTV delineation with the incorporation of PET compared to CT alone [2]. We now present the results of radiotherapy planning parameters.
Methods and materials

Fifteen patients with oesophageal cancer treated with concurrent chemoradiotherapy were identified retrospectively. All patients had a diagnostic FDG-PET CT performed for staging, and a simulation CT for radiotherapy planning (RTP). The RTP CT was the primary dataset on which contours and dose calculations were performed for treatment planning.

Radiation oncologists (ROs) were provided the clinical history and results of relevant investigations for all patients, and institutional guidelines for target delineation. For each patient, four ROs delineated three gross target volumes (GTVs) based on:

1. RTP CT alone with diagnostic PET CT report (GTV_CT)
2. RTP CT fused with PET CT: visual method (GTV_PETvisual)
3. RTP CT fused with PET CT: automated method (GTV_PETauto)

For each patient, two clinical target volumes (CTVs) were delineated by each RO:

1. CTV_CT based on GTV_CT
2. CTV_PETvisual based on GTV_PETvisual

CTVs were expanded by 10mm in all directions to generate planning target volumes (PTV_CT and PTV_PETvisual). A 3D conformal radiotherapy plan was created for each PTV. The prescribed dose was 50.4 Gy. The following parameters of each plan were assessed:

1. PTV coverage: the PTV_PETvisual of a selected RO was used as the reference target volume. The volume covered by 95% isodose line (V95) of each plan was determined for the reference target volume. Plans with V95>95% were considered optimal.
2. Lung dose (mean lung dose, V20Gy)
3. Spinal cord dose (maximum dose)

The values derived from the plans based on RTP CT alone with diagnostic PET CT report were compared with those from the plans based on RTP CT fused with PET CT (visual method). For all comparisons, results of the four ROs were averaged for each patient. Statistical analysis was performed using the paired t-test. Results with a P value of <0.05 were considered statistically significant.
Results

PTV coverage

The PTVs based on RTP CT fused with PET CT (visual method) and the 95% isodoses for patient 4 for all four radiation oncologists are shown in Figure 1 as an example. For each RO, the PTV is shown as a line, and the 95% isodose of the corresponding plan is shown in colourwash in the same colour. The reference PTV is in red. When results for the four ROs were averaged for each patient, PTV coverage was suboptimal in both the plans based on RTP CT and the plans based on RTP CT fused with PET CT for patient 6 (Figure 2). For patients 7, 9 and 12, PTV coverage was optimal in the plans based on RTP CT fused with PET CT, but suboptimal in the RTP CT plans. The difference reached statistical significance in patient 12.

Lung dose

The mean lung doses were similar between the plans for all patients, except for patient 3 in which the mean lung dose was significantly higher in the RTP CT plan, and for patient 9 in which the mean lung dose was significantly higher in the RTP CT+PETvisual plan (Table 1). The lung V20 results were also similar between the plans, except the V20 was significantly higher in the RTP CT plan in patient 3, and significantly higher in the RTP CT+PETvisual plan in patient 9.

Table 1. Mean lung dose (mean value for four radiation oncologists)

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<th>Patient</th>
<th>RTP CT</th>
<th>RTP CT+PETvisual</th>
<th>P value</th>
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<tr>
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</table>

**Spinal cord maximum dose**

There were no statistically significant differences in spinal cord maximum doses between the plans for all patients.
Images for this section:

**Fig. 1:** PTV and 95% isodose for patient 4 for four radiation oncologists

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Fig. 2: PTV V95 by plans (mean value for four radiation oncologists)

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Conclusion

The incorporation of registered PET CT data in oesophageal cancer radiotherapy planning did not result in significant differences in GTV delineation, PTV coverage or doses to normal tissues in the majority of patients. The availability of a diagnostic PET CT report in conjunction with RTP CT appears to be adequate for oesophageal cancer radiotherapy planning.
References
