EP-1918
Radiotherapy quality assurance in the TREC trial

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Purpose or Objective: Transanal Endoscopic Microsurgery (TEM) and Radiotherapy in Early Rectal Cancer (TREC) [1][2] is a randomised phase II feasibility study to compare radical TEM surgery versus short course pre-operative radiotherapy (25Gy in 5 fractions over 5 days) with delayed local excision for treatment of early rectal cancer.
The QA programme for TREC is co-ordinated by the UK Radiotherapy Trials Quality Assurance (RTTQA) group [3][4]. We describe the development of a standardised analysis pipeline and the results of this analysis.

Material and Methods: To ensure consistency and therefore comparability between radiotherapy centres involved in TREC, a detailed radiotherapy protocol was developed. To assess the quality of the plans, 3 (PTVmin, PTVmax, ICRUmax) quantities were measured and recorded. Further investigation was carried out if the relevant objective was not met.
TEMS patients in TREC were treated across 18 UK centres. Radiotherapy plan data was submitted for each of the 87 TEM patients in DICOM format and processed with the Computational Environment for Radiotherapy Research (CERR) software [5]. This enabled i) outlining of target and organ-at-risk structures, ii) dose distribution and dose volume histograms to be assessed (independently) and iii) data format standardisation and automated analysis.

Results:

ROI Objective	Definition
PTV min	D99% ≥ 95% (23.75 Gy)
PTV max	D5% < 105% (26.25 Gy) D2% < 110% (27.5 Gy)
ICRU max	D1.8cc < 110% (27.5 Gy) Lateral patient dose distant from PTV <80% to 85%

Table 1: Summary of quantities assessed during review of radiotherapy plans
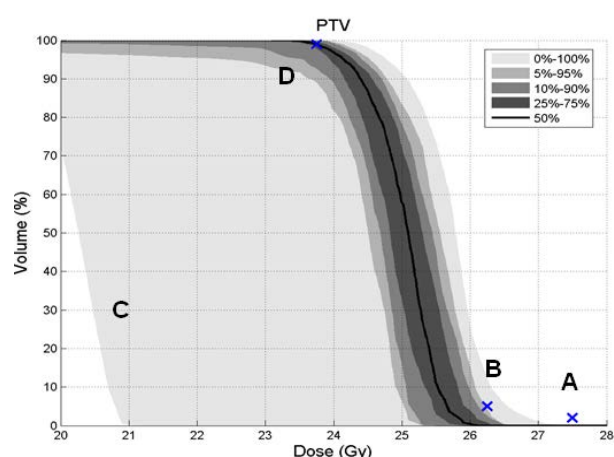

Figure 1: Distribution of PTV coverage

Table 1 shows the ROI objectives outlined in the TREC protocol. Figure 1 shows the distribution of PTV coverage for the 87 TEM patients analysed. All plans achieved D2%<110% (Figure 1, marker A) and 95% of plans achieved D5%<105% (B). Cases of poor coverage (C) were investigated and in 4 cases it was found that the outlined PTV extended beyond the patient surface. In these cases PTV was retracted to within the patient surface and coverage was recalculated.

Conclusion: Deviation from the clinical trial protocol has the potential to confound the study question and quality assurance is therefore essential when comparing different treatments. A high level of conformance was found across the 18 treating centres, with 95% of plans achieving both the minimum and maximum PTV objectives. Our analysis of the radiotherapy plans demonstrates good understanding and adherence to the TREC protocol.
STAR-TREC is an upcoming trial that will amend and extend the TREC pilot. RTTQA findings from TREC will be used to strengthen and improve the STAR-TREC protocol, for example, use of standardised structure names and use of plan-optimisation PTVs to assess target coverage.

References:
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EP-1919
A cost-effective and fast end-to-end test for treatment accuracy evaluation

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Purpose or Objective: End-to-end tests are used to measure the overall accuracy of the radiation therapy chain, excluding patient specific factors. An end-to-end test is a prerequisite to the overall success of any IGRT program. In this work the performance of a cost-effective and fast end-to-end test to assess the geometrical accuracy of the radiotherapy workflow is described.

Material and Methods: The in-house developed phantom for end-to-end testing is depicted in figure 1a. It consists of two Perspex slabs in which a piece of Gafchromic EBT3 film of 4x4cm2 can be placed in. Two notches tighten the film and determine the center and the orientation of the phantom/film respectively. The phantom can be positioned in such a way to have the film in the coronal and sagittal orientation. The total weight of the phantom is about 1kg. A high resolution computed tomography (CT) scan is made of the phantom and a treatment plan (figure 1b) including collimator, gantry and table rotations is computed on this CT. The treatment plan is sent to the linear accelerator. Simulating an actual patient treatment, the phantom is set up on the treatment table using the lasers. Then, cone beam CT guidance is used to adjust the phantom's position with respect to the planning CT. After applying the suggested table shift the plan is irradiated. The films are analyzed using an in-house written Excel macro. The shift required to align the film with the calculated dose plane represents the targeting error. The use of the described phantom for end-to-end testing was compared against two commercial available phantoms.
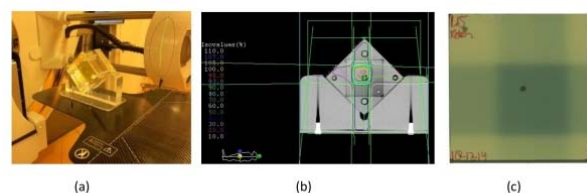

Figure 1 a. End-to-end phantom on the treatment table; b. dose distribution of the plan used for the test; c. corresponding film measurement.

Results: The phantom is light, easy to handle and to set up. Moreover, it is cheap compared to available commercial systems. The phantom allows to assess the overall geometrical accuracy of the treatment chain with sub mm