feedback tool or utilised at a site level during initial planning. Further prospective investigation of the role of KBP in radiotherapy clinical trials is planned.

Poster: RTT track: Image guided radiotherapy and verification protocols

PO-1112 Real-time online matching in high dose treatments: Do RTTs perform as well as physicians?

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Purpose or Objective
For high dose per fraction treatments such as stereotactic body radiotherapy (SBRT) we require a physician to perform the pre-treatment on board imaging (OBI) match. The purpose of this study was to determine if patient matching positioning performed by radiation therapists (RTTs) is as accurate as physician matching.
Material and Methods
Sixteen RTTs and five physicians participated in this study. Data were collected from 113 patients totaling 324 measurements. 60 patients were treated for bone lesions, 53 for soft tissue lesions such as lung and liver. Matching was performed using kV-kV imaging for bones, and cone beam CT (CBCT) for soft tissue. All treatments were delivered on Varian linear accelerators (Palo Alto, CA). The initial match was performed by the RTTs and the shifts noted. The match was then reset, and the physician performed an independent match without prior knowledge of the RTT match. Physician couch shifts were applied for treatment. We used the Mann-Whitney rank sum test to determine statistical significance.
Results
The differences in patient shifts between physicians and RTTs were calculated in three translational and one rotational axis. The average vector shift was 0.88±0.57 cm vs. 0.91±0.57 cm for RTTs vs. physicians respectively. Neither the average vector nor the individual axis shifts were statistically significantly different (p>0.2). There was no significant difference when testing for bony or soft lesion matches separately.
Conclusion
RTT OBI matching is as accurate as physician matching for both bone and soft tissue lesions. Based on these results, RTTs are as qualified as physicians to perform a pre-treatment match. Thus, it may be feasible for the RTTs to perform the match, and the physician to review it off-line, without being present at the machine during treatment. When the RTT team is well-trained this does not compromise patient safety.

PO-1113 Evaluation of CBCT and Orthogonal X-ray for Position verification in Radiotherapy of Prostate Cancer

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Purpose or Objective
In routine practice of modern radiotherapy, cancer patients are scanned with a computer tomography (CT) scanner to obtain a set of CT images (planning CT) for treatment planning. Before treatment delivery, the patient position is verified by using Cone Beam Computed Tomography (CBCT) or conventional orthogonal planar image (OPI), for matching with the planning CT or the digitally reconstructed radiographs (DRR) generated from the planning CT respectively. This study aims at evaluating the dosimetric impact and the matching time of using CBCT and OPI in position verification in radiotherapy of prostate cancer.
Material and Methods
Fifteen prostate cancer patients positioned with CBCT during radiotherapy were recruited retrospectively. OPI were simulated by generating DRR using CBCT in Eclipse™ treatment planning system (Varian Medical Systems, Palo Alto, CA). 3D-3D matching on CBCT/planning CT and 2D-2D matching on simulated OPI/DRR were performed in MIM Maestro™ (MIMSoftware, inc., Cleveland, OH, USA). Time spent on matching was recorded. Treatment plans were created on CBCT and the matching results were applied for dose calculation in Eclipse™.The two position verification methods were compared in terms of Iso-displacement vector (IDV), conformity index and homogeneity index of targets, dose-volume parameters of bladder and rectum in the resultant dose distributions, and matching time consumption. The results were tested using two-tailed Wilcoxon matched pairs signed rank test with a significance level of 0.005.
Results
Largest differences in IDV of CBCT-based and OPI-based position verification were found in antero-posterior direction (average 1.6 mm) and were statistically significant. The conformity index and homogeneity index of targets, the dose-volume parameters of bladder and rectum of the two position verification methods are summarized in Table 1. The use of CBCT resulted in a better conformity and homogeneity of the targets. Dosimetrically, CBCT was superior than OPI in terms of bladder dose but slightly inferior than OPI in terms of rectum dose for position verification. The scatter plot for matching time consumption in CBCT-based and OPI-based position verification in each fractions are shown in Figure 1. The time spent on performing 3D-3D matching and 2D-2D matching were 4.2 ± 0.5 minutes and 1.7 ± 0.3 minutes respectively and the differences were statistically significant.

	CBCT-based positional verification		OPI-based positional verification		Difference is statistically significant ? (p<0.005)
	Mean	SD	Mean	SD	
Conformity Index (PTV)	0.654	0.088	0.628	0.100	Yes
Homogeneity Index (Prostate bed)	0.053	0.033	0.062	0.043	Yes
D_{mean} (bladder) [Gy]	71.724	1.274	71.941	1.251	Yes
V_{65Gy} (bladder) [cc]	20.416	13.936	21.824	14.699	Yes
D_{mean} (rectum) [Gy]	70.573	1.477	70.079	1.883	No
D_{50} (rectum) [Gy]	22.924	16.829	22.216	16.018	No

Table 1: Summary of the conformity and homogeneity of the targets and the dose-volume parameters of bladder and rectum in the resulted dose distributions of the CBCT-based and OPI-based positional verifications

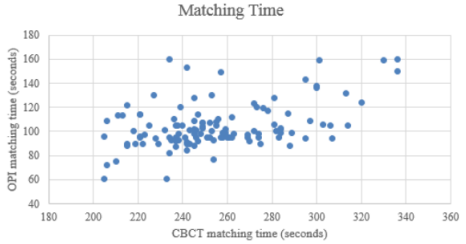

Figure 1: Scatter plot for matching time consumptions in CBCT-based and OPI-based positional verifications.

Conclusion
CBCT-based position verification yields a significant different IDV and is dosimetrically beneficial comparing with OPI-based position verification in radiotherapy treatment of prostate cancer. However, in addition to CBCT acquisition time, CBCT-based position verification requires a longer matching time than OPI-based position verification. Therefore, the choice of position verification

methods should depend on the availability of resources in the radiotherapy department and the tolerance on the treatment accuracy.

PO-1114 Organ motion characterization by a novel fiducial marker in esophageal cancer radiotherapy

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Purpose or Objective

A novel fiducial marker was explored for use in image-guided radiotherapy (IGRT) of esophageal cancer patients by characterizing inter- and intra-fractional organ motion.

Material and Methods

Twelve esophageal cancer patients proposed for radiotherapy participated in this pilot-study. Markers (1-6 per patient) were implanted EUS- guided prior to radiotherapy planning CT (CT_P) with additional 4DCT, and the patients received IGRT (23-33 fractions, 41.4-66.0 Gy) with daily cone beam computed tomography (CBCT, n=302) and/or orthogonal planar images (2D/2D, n=61) and a repeated CT- and 4DCT the last treatment week. Marker presence, planning target volume (PTV) coverage, centroid position and extreme positions on CBCT were recorded per patient and -treatment fraction. Inter- and intra-fractional motion were characterized, in all patients and grouped according to marker location.

Results

At treatment end, 92% of markers visible at CT_P were still present. The PTV accounted for marker variation in >95% of treatment fractions for 92% of the patients. Overall 3D inter-fractional variation was >1cm in 23% and >0.5cm in 58% of the markers. Median (IQR) intra-fractional motion of all markers was 1.2 cm (0.4 cm) in the longitudinal, 0.11 cm (0.51 cm) in the ventral and 0.0 cm (0.13 cm) in the lateral direction.

Conclusion

The use of the investigated fiducial marker may be beneficial for IGRT in esophageal cancer as the marker loss during radiotherapy was limited. Inter- and intra-fractional variation was substantial with largest motion in the longitudinal direction and more pronounced in the caudal part of esophagus.

PO-1115 The UK lung SABR survey on behalf of the Advanced Radiotherapy Technologies Network

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Purpose or Objective

SABR has become the standard of care for patients with medically inoperable early stage non-small cell lung cancer or for patients who decline surgical resection. In the UK a limited number of centres are commissioned by the NHS to provide this treatment. The delivery of large doses of radiotherapy is potentially associated with serious toxicity. Therefore strict image guidance protocols are required to ensure its safe delivery.

To build a comprehensive national picture of SABR provision, and the barriers faced by centres attempting to implement SABR, a survey was conducted on behalf of the UK Advanced Radiotherapy Technologies Network (ART-NET). In particular this focused on image guidance and the management of anatomical changes.

The aim was to identify any variation in current practice and areas where guidance may require updating. This work will inform the development of adaptive protocols for novel treatment platforms.

Material and Methods

An online survey was created and piloted amongst ART-NET member centres. This was then disseminated electronically to radiotherapy service managers in all UK NHS centres.

Results

100% of NHS centres responded to the survey. 36/62 UK centres deliver lung SABR. Of these, 6 English centres provide SABR despite not being commissioned to do so. 56% of SABR centres treat 20-100 patients per year, and 19% treat fewer than 20 patients per year. Lack of national commissioning was cited as the most common barrier to implementation by non-SABR centres (86%). These centres will refer appropriate patients to a SABR centre, although 62% also provide conventionally fractionated radiotherapy as a local alternative.

Most variation was seen in the frequency of cone-beam computed-tomography (CBCT); 8 different CBCT workflows were reported. Only 52% of centres have a protocol for addressing the impact of anatomical changes. Overall, 67% of centres planning to develop a service in the next year believe image guidance protocols require updating. The most commonly suggested topic was the frequency of image guidance including the necessity of pre or post-treatment scans.

Conclusion

Eligible patients may face difficulty accessing SABR due to a lack of commissioning in some centres. This issue should be investigated further to ensure there is equitable access to lung SABR in the UK. There is a need to update existing guidelines, as evidenced by the heterogeneity in image guidance practice across the UK. These should also incorporate advice on the management of anatomical changes and will inform future adaptive IGRT protocols on novel radiotherapy platforms such as the MR-linac.

PO-1116 Set-up in locoregional breast irradiation: reduced margins for subclavicular and axilar lymph nodes.

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Purpose or Objective

For locoregional irradiation of the breast, tangential fields to the breast were combined with VMAT to achieve steep dose falloff around the lymph node levels I-IV. After introduction of this new planning technique, setup instructions were adapted with additional focus on these lymph node regions. This allowed for reduction of the CTV-PTV margin in the lymph nodes, from 8mm to 5mm in all directions.

Material and Methods

21 breast cancer patients with 47 sessions were included in this study. Treatment plans consisted of tangential, ventrally open fields which delivered most of the dose to the breast and VMAT which delivered most of the dose to the nodal area.

Setup was performed based on 2 orthogonal 2D kV images. Instructions for this setup defined a maximum misalignment of 5mm in the bony anatomy in the lymph node regions, and 8mm in the humeral head and the