missing baseline drift in the images, an artificial tumor representation (ATR) was generated and placed in the healthy lung (see Fig. 1). Its motion trajectory is equivalent to the one of the real tumor. For evaluation purposes a static drift of 20mm has been incorporated.

Results: Tracking results were compared to reference data generated by manual tumor tracking (see Table 1).

<table>
<thead>
<tr>
<th>Tumor Tracking</th>
<th>ATR Tracking</th>
<th>ATR + 20mm Drift</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean error L-R (mm)</td>
<td>0.8</td>
<td>0.9</td>
</tr>
<tr>
<td>mean error S-I (mm)</td>
<td>0.6</td>
<td>2.4</td>
</tr>
</tbody>
</table>

The mean error was 0.8mm in L-R and 0.6mm in S-I direction and the mean computational time accounted for 2.3ms. The accuracy of ATR tracking was compared to the ground-truth used for ATR generation. The mean error for normal ATR respiratory motion was 0.9mm (L-R) and 2.5mm (S-I) whereas with the baseline drift it accounted for 1.9mm (L-R) and 5.3mm (S-I).

Conclusions: A template matching based method for real-time detection of lung tumor motion in projection images has been developed. The presented algorithm is robust against tumor overlaps and additional motion influence. Further evaluation of the presented approach on additional image data is required. The applicability of this method on other imaging modalities warrants further research. This research was carried out with the support of the German Research Foundation (DFG) as part of project C01, SFB/TRR 125 Cognition-Guided Surgery.

Purpose/Objective: Accurate assessment of hilar and mediastinal lymph node (LN) status in NSCLC is essential for reliable TNM-staging and treatment decision-making on per-patient basis (surgery vs. chemo-radiotherapy). Moreover, accurate staging of individual LNs is crucial for selective nodal irradiation. We therefore analysed the diagnostic value of MRI in detecting and differentiating (non-)metastatic regional LNs on both per-patient and per-nodal basis, in reference to cytology or histology, and compared it to that of FDG-PET/CT.

Materials and Methods: A systematic literature search was performed in PubMed, Web of Science, Embase, and MEDLINE. The methodological quality was evaluated using QUADAS-2 and Deeks’ funnel plots. Hierarchical summary ROC curves were generated to estimate the pooled diagnostic power of MRI in N-staging NSCLC [sensitivity, specificity, and diagnostic odds ratio (DOR)]. For comparison, data from four equivalent meta-analyses on FDG-PET/CT was used. Subgroup analyses, expressed as relative DOR (rDOR), were performed to evaluate whether publication year (before 2008 vs. thereafter) and method of evaluation (quantitative vs. qualitative) affected the overall diagnostic performance of MRI.

Results: Of 2551 initially identified studies, 12 eligible studies were included in this meta-analysis. On per-patient basis, the pooled estimates [95% CI] for sensitivity, specificity, and DOR were 0.87 [0.78-0.92], 0.88 [0.77-0.94], and 48.1 [23.4-98.9], respectively. On per-nodal basis, the respective measures were 0.88 [0.78-0.94], 0.95 [0.87-0.98], and 129.5 [49.3-340.0]. These results are set against recently published FDG-PET/CT data revealing an average sensitivity and specificity of 0.74 and 0.89, respectively, on per-patient, and of 0.68 and 0.93, respectively, on per-nodal basis (Table 1). Subgroup analyses showed an increased DOR for per-patient based studies published after 2008, while the DOR decreased for per-nodal based studies. The discriminatory power of quantitative evaluation was significantly greater than qualitative evaluation on per-nodal basis (rDOR=7.25 [1.75-30.09], P=0.01).

Poster Discussion: Young Scientists 9: RTT Pre-treatment imaging; adaptive radiotherapy; geometric uncertainties and margins

PD-0465 MRI may replace FDG-PET/CT for selective lymph node irradiation in NSCLC radiotherapy: results of a meta-analysis J. Peerlings1, E. Troost1, P. Nelemans1, R. Beets-Tan1, A. Hoffmann2

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Conclusions: This meta-analysis demonstrates Level-II evidence of the high diagnostic performance of MRI in staging hilar/mediastinal LNs in NSCLC on both per-patient and per-nodal basis. Relative to FDG-PET/CT, pulmonary MRI is able to reach higher sensitivity at similar specificity, encouraging future prospective studies on treatment decision-making and selective nodal irradiation in NSCLC. However, before pulmonary MRI can replace FDG-PET/CT in NSCLC radiotherapy, thorough assessment of geometric distortion in MR images is mandatory.

PD-0466
Range Probe: a technique to detect patient misalignments
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Purpose/Objective: The advantage of proton therapy is the presence of a sharp distal dose fall-off that can be used to spare normal tissues beyond the end of the delivered field. However, due to this sharp fall-off, even small errors resulting from patient misalignments could potentially result in a significant discrepancy between the planned and the delivered dose. Therefore, to tap the full potential of proton therapy, accurate and on-line methods to verify the patient positioning and the proton range during the treatment are desirable. Here we propose and validate a fast and innovative technique for determining shift and rotational positional uncertainties for proton therapy using what we call 'range probes'. A range probe is a narrow, high energy proton pencil beam that shoots through the patient and can be detected on exit and for which the residual range and shape of the Bragg peaks (BP) can be measured using a multi-layer-ionisation-chamber (MLIC) (see Figure 1). By the use of a number of carefully selected range probe positions, the ranges of the detected BP's can uniquely define the orientation of the patient.

Materials and Methods: To validate this approach, an anthropomorphic phantom has been used, and a planning CT acquired. From this, 700 new CT's were generated, assuming different rotations along each axis. Five low dose range probes with energy 177 MeV were then simulated to pass through all these CT data sets using the VMCPro Monte Carlo code, with the residual BP's of each range probe being stored in a database to which experimentally measured range probe BP's can be compared. The phantom was then placed on a rotation device and three new CT's with randomly generated rotations were acquired, representing three possible daily positioning's of the patient. To determine these 'daily' rotational positioning errors, range probes were simulated through these 'daily' CT data sets, and the results compared to the pre-calculated data base, from which the actual 'daily' rotational error could be determined.

Results: In Table 1 the comparison between the predicted rotations and the daily errors are reported for the three studied cases. The calculation performed shows that a rotational positioning errors of the phantom can be detected with a resolution of about δrot=1°.

<table>
<thead>
<tr>
<th>Actual rotational error (randomly determined)</th>
<th>Predicted rotational error using 5 range probes</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°; 0°; +1.8°</td>
<td>0°; 0°; +2.0°</td>
<td>0°; 0°; 0.2°</td>
</tr>
<tr>
<td>+1.4°; -1.8°; 0°</td>
<td>+2.0°; -2.0°; 0°</td>
<td>0.8°; 0.2°; 0°</td>
</tr>
<tr>
<td>-1.4°; -2.1°; -1.4°</td>
<td>-2.0°; -1.0°; -1.0°</td>
<td>0.6°; 1.1°; 0.4°</td>
</tr>
</tbody>
</table>

Conclusions: With this phantom study we have demonstrated the possible use of a small number of proton range probes for detecting on-line, residual rotational misalignments of patients with a high level of accuracy. The technique is fast and can effectively reconstruct three-dimensional positioning errors from a single proton beam angle. Even if further investigations and measurements are required before the method can be applied in clinical routine, our simulations and measurements have shown the feasibility of the approach.

PD-0467
Adaptive, preoperative radiotherapy with image guided Tomotherapy concomitant with chemotherapy in rectal cancer
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Purpose/Objective: To report the clinical results of a five years experience in the neo-adjuvant treatment of rectal cancer within a moderate hypofractionated regimen (18