enhanced inspiration gating (EIG), for supra-diaphragmatic HL radiotherapy.

Materials and Methods: To date, five patients (two female, three male), median age 39 years (20-46 years), with supra-diaphragmatic HL have been enrolled in this on-going study. The patients had a staging PET/CT before chemotherapy and a planning CT in both free breathing (FB) and EIG [5]. During EIG, the breathing was monitored using the RPM system (Varian Medical Systems) and the median distance to the lower part of the gating window was 9.8 mm. Target volumes and OARs were delineated in both CT sets. The same PTV margin was used for both EIG and FB. For each patient an involved-node radiotherapy plan, with comparable PTV coverage, was constructed in both CT sets using AAA version 10.0.28 in Eclipse (Varian Medical Systems). AP/PA field orientation (6 MV) was used and additional fields with lower weight were added for dose homogenization (6 or 10 MV). The prescribed dose was 1.8 Gy in 17 fractions (four patients) or 1.8 Gy in 20 fractions (one patient). The PTV volume receiving more than 95 % of the prescribed dose (V95%), the mean heart and lung doses and the heart and lung volumes receiving more than 20 Gy (V20Gy) were respectively recorded from Eclipse for each CT set to investigate whether EIG decreases the absorbed dose to OARs during supra-diaphragmatic HL radiotherapy.

Results: Four of the five patients were treated using EIG. For comparable PTV coverage (median V95% of 88.0 and 90.4 % for EIG and FB, respectively), the absorbed dose to the heart and lungs were reduced for EIG compared to FB (table 1, figure 1).

Table 1 Dosimetric comparison between enhanced inspiration gating (EIG) and free breathing (FB). Data presented as median values and range in brackets.

<table>
<thead>
<tr>
<th></th>
<th>FB</th>
<th>EIG</th>
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<tbody>
<tr>
<td>Mean heart dose (Gy)</td>
<td>15.4 [9.0-20.7]</td>
<td>12.8 [8.9-17.4]</td>
</tr>
<tr>
<td>Heart V95% (%)</td>
<td>41.8 [3.8-66.6]</td>
<td>34.1 [4.0-53.6]</td>
</tr>
<tr>
<td>Mean lung dose (Gy)</td>
<td>10.7 [7.7-16.5]</td>
<td>9.2 [7.2-11.9]</td>
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<tr>
<td>Lung V20Gy (Gy)</td>
<td>26.3 [17.3-44.7]</td>
<td>22.6 [15.4-29.1]</td>
</tr>
</tbody>
</table>

Conclusions: Using EIG for supra-diaphragmatic HL radiotherapy appears dosimetrically favorable for the heart and lungs compared to FB. The results presented are preliminary and more patients will be enrolled in the study.

References

EP-1485
Changes in intrafractional motion due to the introduction of a Flattening Filter Free treatment technique
W. Nielsen¹, C.R. Hansen¹
¹Odense University Hospital, Laboratory of Radiation Physics, Odense, Denmark

Purpose/Objective: Stereotactic radiotherapy is intrinsically more sensitive to intrafractional motion (IFM) of the patient due to the low number of fractions. Furthermore, delivering large doses per fraction may increase the risk of IFM due to the extended beam-on time of these treatments. The introduction of Flattening Filter Free (FFF) treatment technique can reduce the beam on time by up to 60%. The purpose of this study is to evaluate the possible reduction in this movement in patients treated with stereotactic radiotherapy in lung (66 Gy/3F) and brain (20 Gy/1F) due to the introduction of a FFF technique.

Materials and Methods: All patients in this study were treated with VMAT on Elekta linacs and imaged using the XVI system. 451 filter-flattened (FF) and 294 FFF treatment fractions targeting a lung tumour were analyzed. They were immobilized on a BreathsSTEP board (Elekta) with arms above the head. Imaging was carried out using 4D CBCT soft tissue match prior to irradiation, and patient position was corrected in 3 dimensions. Halfway through each fraction a repeat 4D CBCT was performed. IFM was estimated by considering the difference between the pretreatment scan and the halfway scan. For stereotactic surgery of the brain, 19 FF and 57 FFF fractions were considered. These patients were immobilized with the Orfit HP system. A grey value match on brain and cranial bone was performed, and patient position was corrected in 6D using the iGuide system. Subsequently the patient position was verified on a check CBCT scan. After all coplanar arcs were delivered a repeat CBCT was carried out. IFM was estimated by considering the difference between the check scan and the halfway scan.

Results: Lung: For FF treatments the average time interval from the prior scan to the halfway scan was 9:46 min. The length of the vectorial IFM had a mean of 2.2mm, a maximum of 19.2mm and 95% of the cases had a motion of less than 4.5mm. For FFF treatments the average time interval from the check scan to the halfway scan was 7:44 min. The length of the vectorial IFM had a mean of 2.0mm, a maximum of 15.8mm and 95% of the fractions had a motion of less than 5.4mm.

Brain: For FF treatments the average time interval from the check scan to the halfway scan was 6:01 min. The length of the vectorial IFM had a mean of 0.4mm, a maximum of 1.6mm and 95% of the cases had a motion of less than 0.8mm. The mean of all measured angular corrections was 0.4 deg; with a maximum of 1.5 deg. 95% of all angles were smaller than 1.0 deg. For FFF treatments the average time interval from the check scan to the halfway scan was 4:30 min. The length of the vectorial IFM had a mean of 0.5mm, a maximum of 1.6mm and 95% of the cases had a motion of less than 1.1mm. The mean of all measured angular corrections was 0.3 deg; with a maximum of 1 deg. 95% of all angles were smaller than 0.8 deg.
I. Pytko for intra-fractional monitoring during radiosurgery

Feasibility study of using a radiofrequency tracking system

Conclusions: The intrafractional motion was not reduced due to the reduction in treatment time.

EP-1486

Feasibility study of using a radiofrequency tracking system for intra-fractional monitoring during radiosurgery

Purpose/Objective: Stereotactic treatments require high geometrical accuracy of the whole treatment chain to safely deposit the dose in the tumor while sparing the healthy tissue. Modern linear accelerators perform radiosurgery (SRS) treatments with sub-millimeter accuracy in dose delivery, as well as image guided patient setup. However, intrafractional patient motion is a source of uncertainty in these treatments. The feasibility of using the Calypso (Varian, USA) radiofrequency tracking system for intra-fractional motion monitoring during cranial SRS treatments was evaluated.

Materials and Methods: Studies were performed using the Calypso system with the wireless surface transponder that consists of 2 orthogonally connected electromagnetic resonance circuits. A magnetic source and receiver coil array are used to determine the transponders' positions. The electromagnetic array is tracked in real time relative to the isocenter through the use of an infrared optical-tracking system. For the measurement, the Alderson head phantom was used and 3 volunteers participated in the studies. The Calypso surface transponders were positioned with a sticky tape behind the ear, close to the auricle of the phantom and volunteers. Accuracy of couch shifts and couch rotations were evaluated and compared to results from optical surface monitoring system (OSMS, Varian, USA). As the Calypso tracking volume is limited to a cylinder with 9 cm radius, a height of 21 cm and center of mass at the isocenter, additional feasibility of placing the transponders behind the ear was retrospectively evaluated from CT scans of 40 intracranial tumor volumes, 36 were in the tracking cylinder of Calypso and would therefore be feasible to treat with the system.

Conclusions: Intra-fractional motion can be monitored using the Calypso system with an accuracy of less than 1 mm necessary for the SRS treatments. The volunteer studies showed the possibility of using the Calypso surface transponder positioned behind the ear for the stereotactic treatments. 90% of the studied intracranial patients would qualify for the SRS treatment using Calypso.

EP-1487

Investigation of gating techniques and visual guidance using surface scanning and pressure monitoring

Purpose/Objective: The purpose of this study was to evaluate and compare enhanced inspiration gating (EIG) and deep inspiration breath hold (DIBH), with and without visual guidance. The study also included pressure measurements to investigate the potential risk of patient lifting during DIBH.

Materials and Methods: Twenty healthy female volunteers were included in the study. The volunteers performed both EIG and DIBH, with and without visual guidance. Based on a practice session a 3 mm gating window was introduced at an individual amplitude for both EIG and DIBH. To monitor the breathing and have access to visual guidance the Catalyst (C-RAD positioning AB, Uppsala, Sweden) was placed under the patients scapulas. These novel pressure measurements were used to evaluate any potential risk of patient lifting to enter the gating window during DIBH, and thus not increasing the spatial distance between the heart and the target volume. The last step in the study was to investigate how long time the volunteers were able to hold their breath in the gating window.

Results: Spontaneously, without visual guidance, the volunteers breathed significantly deeper using DIBH compared to EIG, and thus potentially increased the distance between the heart and the target volume. The average chest amplitude for EIG was 10.8 ± 4.7 mm (1 SD) and for DIBH 12.9 ± 5.8 mm. The reproducibility and Pgw improved for both techniques when visual guidance was added. The stability did not indicate any particular trend. The pressure measurements showed that there was a possible risk that the volunteers lifted from the couch during DIBH, which was more prominent for high amplitudes (~2.5 cm) and when visual guidance was used. On average the volunteers where able to hold their breath for 57.2 ± 22.5 s.

Conclusions: According to this study there are major advantages using DIBH and visual guidance. DIBH resulted in higher amplitudes which could result in sparing of cardiac...