Parietal tumor localization was a predictor for a higher contralateral hippocampal dose \( (p=0.01) \).

Conclusion: A substantial reduction of the dose to the contralateral hippocampus is technically feasible when VMAT is used instead of our standard 3D-CRT planning strategy. The amount of sparing that can be achieved strongly depends on the individual patient geometry. Whether this approach is able to conserve the neurocognitive status without compromising the oncological outcome for patients with glioblastoma needs to be investigated in the setting of prospective clinical trials.

EP-1674

Should VMAT be routinely applied to treat sacral bone metastases?

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Purpose or Objective: Bone metastases are a frequent and disturbing complication of cancer. The challenge of optimizing dose coverage of the concave shape of the sacrum along with its close proximity to the rectum, intestines and femoral heads lead us to investigate whether the VMAT technique is advantageous when compared to 3D treatment.

Material and Methods: Twenty three consecutively treated patients with sacral metastases in 2013-2014 were included in a comparative treatment-planning study evaluating VMAT and 3-D planning. The statistical analysis included the T-test, assuming Unequal Variance (one tail). Calculation of the \( p \)-value for the comparative results applied. Our null hypothesis was that VMAT is better than 3D technique, and our alternative hypothesis was that 3D technique is superior to VMAT.

Results: The PTV coverage was identical in VMAT and 3D planning. Median values and V15 for the intestinal exposure showed no statistically significant difference between the 3D planning and VMAT: 9.28 Gy (SD 2.25) and 47.0 ml (SD 68.62) versus 8.97 Gy (SD 2.18) and 18.45 ml (SD 69.56), respectively. However, on an individual per case assessment it appears that the lower exposure of the bowel depends on the small bowel/sacrum volumes ratio. The benefit for VMAT emerges if such a ratio exceeds one. The median values for the rectum 3D and VMAT were 11.34 Gy (SD 5.14) and 7.7 Gy (SD 2.76), respectively. The median 3D and VMAT exposure of the femoral head were 1.78 (SD 2.94) Vs 4.06 (SD 2.1) on the left and 1.74 (0.9) Vs 4.26 (SD 1.8) on the right side for the 3D and VMAT, respectively.

Conclusion: Good sacral coverage is achievable with either 3-D or VMAT approaches. VMAT is advantageous vis-à-vis the rectal exposure and when relatively large amounts of small bowel course through an individual patient’s fields. The 3-D approach, however, retains benefit for femoral protection, a finding that may have implications for patients with arthritis and osteopenia.

EP-1675

Total body irradiation with Tomotherapy

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Purpose or Objective: In Conventional Radiotherapy (CRT), Total Body Irradiation (TBI) is generally performed at long Source Skin Distance using diodes to drive the delivered dose. The dose distribution is usually not well assessed (measured only in a few points) and was shown to be strongly heterogeneous. This technique also leads to acute and late toxicity. Helical Tomotherapy (Accuray Inc., Sunnyvale, CA) for TBI is implemented in some centers. Compared to CRT, Tomotherapy allows the delivery of the prescribed dose with a high level of accuracy and homogeneity. Organs-at-risk can be spared and the dose distribution is known before the treatment. Two technical issues have to be solved. First, the patient must be treated using two plans, head first (HF) and feet first (FF) due to limited supero-inferior (SI) table motion. At the junction of these two plans, the dose must be delivered with particular care. Moreover, the planning target volume (PTV) is the entire body, including the skin. A safety margin in the air surrounding the body should be added to take into account setup errors. Using inverse planning, however, can result in over-fluence peaks in the skin region. The aim of this work is to present our solution for these two issues, our optimized planning protocol and our clinical results after one year of practice (outcome for 15 patients).

Material and Methods: Patient treatment position is shown hereafter. Thermoplastic masks are placed on the head and the thorax (not the legs). Two CTs are acquired (HF and FF). At the planning station, the whole body (cropped 3 mm under the head) is divided into 10 PTVs. At the junction (halfway up the thighs), 4 PTVs (thickness 2 cm) are drawn to deliver the dose with the degraded penumbra methodology: decreased dose is delivered during HF plan and increased dose during FF plan. Different sets of doses were tested. The resulting dose distribution in the presence of simulated set-up errors (SSUE) is computed to find the combination that insures optimal dose coverage of the junction. Moreover, to insure dose coverage of legs in presence of SSUE, several Virtual Boluses (VB) were tested. A VB is a bolus added at planning, but not present during treatment. Several thicknesses and densities were tested on a phantom study: in presence of SSUE, the dose coverage and dose increase (due to the methodology) were assessed.

Results: The best combination of PTV doses at the junction is presented in table: V95% stays higher than 96% even in the case of a SSUE of 1 cm (SI). The optimal VB is an 8 mm thick VB (density=0.4). This allows a good coverage (V95%-95%) for a large lateral SSUE (up to 2.9 cm). Underestimation of dose using this VB (planning vs measure) is 1.5%.

<table>
<thead>
<tr>
<th>Dose plan HF</th>
<th>Dose plan FF</th>
<th>Total Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slice 1</td>
<td>10.74</td>
<td>1.26</td>
</tr>
<tr>
<td>Slice 2</td>
<td>7.56</td>
<td>4.44</td>
</tr>
<tr>
<td>Slice 3</td>
<td>4.44</td>
<td>7.56</td>
</tr>
<tr>
<td>Slice 4</td>
<td>1.92</td>
<td>10.00</td>
</tr>
</tbody>
</table>

Conclusion: This study presents our optimized planning parameters. Since November 2014, 15 patients were treated with a dose of 2 or 12 Gy. Dose to lungs was limited to 9 Gy.
Most of the patients have been treated for acute leukemia with allogeneic transplant.

EP-1676
Sparing potential of scanned protons for the treatment of intramammary nodes in breast radiotherapy
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Purpose or Objective: Breast cancer patients are among the long-term survivors of radiotherapy and therefore the long-term cardiopulmonary toxicity due to the treatment should be reduced to a minimal. However, complication rates could be further increased when intramammary nodes are included in the target due to their proximity to the heart and the lungs. Several techniques could be used to decrease the dose to the normal tissues and consequently the rates of late complications, including proton beam radiotherapy and respiratory gating. This study aims to investigate the potential for normal tissue sparing for the treatment of intramammary nodes in breast cancer radiotherapy using scanned proton beams with or without respiratory gating.

Material and Methods: The study was performed on CT-datasets acquired from ten left-sided patients during enhanced inspiration gating (EIG) and free-breathing (FB). The patients were planned with intensity modulated proton therapy (IMPT) for locoregional breast treatment. The prescribed dose to the target was 50 GyRBE in 25 fractions, assuming an RBE of 1.1. Different plans were performed for breast and supraclavicular nodes respectively breast, supraclavicular and intramammary nodes (IMM). The implications of including IMM in the target volume were evaluated from the point of view of the doses to the organs at risk for cardiopulmonary complications.

Results: Inclusion of the IMM in the target volume led to a small increase of the cardiopulmonary burden. Thus, in FB cases the average dose to the heart increased from 0.3 to 0.4 GyRBE and the average dose to the lung increased from 6.1 to 6.6 GyRBE, while the average dose to the left anterior descending artery (LAD) decreased from 4.1 to 3.8 GyRBE. For EIG cases the average dose to the heart was almost unchanged (0.2 GyRBE), the average dose to the lung increased from 6.9 to 7.4 GyRBE and the average dose to the LAD decreased from 3.3 to 2.6 GyRBE. Other dosimetric parameters of interest showed a similar trend when IMM were included in the target. These parameters are much lower than those that could be achieved in conventional radiotherapy with photons, especially with respect to the cardiovascular burden, irrespective of whether respiratory gating is used or not.

Conclusion: The results of this study indicate that radiotherapy with scanned proton beams has the potential of significantly limit the cardiopulmonary burden compared to photon RT when including the IMM in breast cancer radiotherapy.

EP-1677
Comparison of different techniques in lung SABR using VMAT with deep inspiration breath hold
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Purpose or Objective: Stereotactic ablative radiotherapy (SABR) for the lung primary and metastatic tumors aims to increase the local control, survival and quality of life. Deep inspiration breath hold (DIBH) using 4D CT for simulation minimizes respiratory motion and reduces the toxicity risk by decreasing margins. In this study, we aimed to compare the dosimetric results of different devices and techniques of SABR using volumetric arc therapy (VMAT) with DIBH in the lung tumors.

Material and Methods: CT datasets of 7 patients with right-sided lung cancer performed with RPM system (Varian, Palo Alto) was used. Median PTV was 13.2cc. Dose prescription objective was to cover 98% of the target volume by D98% which was 50 Gy/5 fractions. Four different VMAT plans were made on Eclipse TPS (Varian, Palo Alto) using AAA algorithm. Plan A consisted of TrueBeam, 120HDMLC, 6MV-FFF, without jaw tracking, Plan B TrueBeam, 120HDMLC, 6MV-FFF, with jaw tracking, Plan C TrueBeam, 120HDMLC, 6MV, without jaw tracking, Plan D with Trilogy, 120MilleniumMLC, 6MV, without jaw tracking. Three partial arcs using 210 degrees were used to generate the plans under the same optimization conditions. Monitor Unit (MU), beam-on time (B0T), Gradient Index (GI), lung V20 and V5, dose at 2 cm from PTV (D2cm), PTV(Dmax) and PTV(Dmin) were assessed for comparison. Wilcoxon test was used for statistical evaluation.

Results: No statistically significant differences were found for total MU, D2cm and PTV(Dmin) between the four plans. Mean PTV(Dmax) values were lower in Plan C with HDMLC compared to Plan D with MilleniumMLC (122.9±3.9 vs 126.8±3.7, p<0.018). At GI assessment; there was no significant difference between plans with and without jaw-tracking. However, there was a significant difference between Plan C and Plan D (4.4±0.5 vs 4.8±0.6, p<0.018); and Between Plan A (FFF) and Plan C (FF) (4.2±0.4 vs 4.4±0.5, p<0.018). V20 and V5 was lower in Plan C compared to Plan D (2.8%±1.5 vs 3.3%±1.5, p<0.028 and 15.1%±5.3 vs 16.5%±5.6, p<0.018); V5 was lower in Plan A compared to Plan C (14.4%±5.1% vs 15.1%±5.3%). BO T was significantly shorter between Plan A and Plan C (167.3 sec±20.4 vs 390.5 sec±47.8, p<0.018).

Conclusion: In SABR with WMAT using DIBH, we observed some improvements by using HDMLC compared to MilleniumMLC and FFF compared to FF beams. However, we could not observe additional benefit with jaw tracking in the FFF mode. Major advantage of FFF was the shorter B0T, which may finally improve the patient compliance in SABR using DIBH technique.

EP-1678
VMAT in locally advanced lung cancer; does it add benefit? M. Kamaledin, M. Al Daly, S. Talima
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Purpose or Objective: In locally advanced NSCLC Concurrent chemo/Radiation is the key most important treatment approach. However delivering adequate radiation dose to improve treatment results is limited by the tolerance of nearby structures (lungs, esophagus, heart etc...), and by the intrafractional uncertainties resulting from prolonged treatment time of the conventional techniques. We have compared VMATPlanes Vs. 3D CRT in inoperable advanced lung cancer cases.

Material and Methods: Ten cases of previously treated lung cancer with 3DCRT planes ( minimum of 4 beams) were replanned with VMAT optimization using 2 half arcs. Both planes were performed on Eclipse® planning system (version 11) with AAA-algorithm and linear accelerator UNIQ® of energy 6Mv, dose rate of 600 CGy/min , and 120 multileaf collimator. The dose was prescribed as 60GY / 30fr to the CTV surrounded with margin of 1.5cm for the PTV. Plans were compared for coverage , avoidance of organs at risk , and total number of MU.