consistent with standard clinical practice. However, to facilitate linear interpolation between MC calculated values the simulated field sizes should be increment in steps of 0.05 cm.

**PROFFERED PAPERS: RTT 1: GEOMETRIC UNCERTAINTIES: A MULTIFACTORIAL PROBLEM?**

**OC-0069**

Dosemetric consequences of total marrow irradiation positioning with volumetric modulated arc therapy

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**Purpose/Objective:** Total marrow (and lymph nodes) irradiation (TMI and TMLI) by volumetric modulated arc therapy (VMAT) was shown to be feasible. Many arcs with different isocenters are required to best cover the hematopoietic or lymphoid tissues target and to spare the neighboring healthy tissues according with ALARA principle. The direct consequence is the necessity of overlapping regions between neighbor arcs. In this study we evaluated the dosimetric consequences of inaccurate isocenter positioning during the treatment of TMI and TMLI treatments using volumetric modulated arc therapy (VMAT).

**Materials and Methods:** Two plans were randomly selected from the internal database of patients treated with TMI or TMLI using VMAT technique (one per case). Dose prescription was 12 Gy to target in 6 fractions, 2 times per day for TMI, and 2 Gy in single fraction for TMLI. All body bones were defined as PTV. For TMLI, treatments lymph nodes and spleen were considered too. Ten arcs on 5 isocenters (2 arcs for isocenter) were used to cover the upper part of PTV (i.e., from cranium to middle femurs). For each plan, two series of random shifts (between -3 to +3 and -5 to +5 mm) were applied in each single direction (Left-Right (LR), Anterior-Posterior (AP), Cranial-Caudal (CC)) for each isocenter (total of 60 random shifts) simulating involuntary patient motion during the treatment. The shifted plans were recalculated with the same monitor units and compared to the reference ones in terms of target coverage (mean dose to PTV, \(V_{95}\%\) i.e., %volume receiving at least 80% of the prescription dose), \(V_{80}\%), \(V_{110}\%), Homogeneity index (HI=(\(D_2-D_{98}\))) and body in terms of mean dose and max dose (i.e., \(D_{mean}\)).

**Results:** No substantial differences (0.5%) were found for mean dose and \(V_{95}\%\) to PTV, and mean dose to body between the reference plans and the ones randomly shifted in the 3 directions. For all other parameters there was a worsening with random shift increasing. In particular the differences were <1% and <4% in LR and AP in case of respectively, 3 mm and 5 mm random shifts, but became higher for CC.

**Conclusions:**

The correct isocenter repositioning of TMI-TMLI patients is fundamental, in particular in CC direction. A dedicated immobilization system was developed in our center to best immobilize the patient.

**OC-0070**

Comparison of setup accuracy of two immobilization systems for head and neck treatment by daily MVCT Tomotherapy

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**Purpose/Objective:** The purpose of this study was to compare the setup accuracy of two different immobilization systems for radiotherapy at head and neck region.

**Materials and Methods:** 36 head and neck patients were recruited in this study, of which is composed by patients using the Orfit immobilization system (n=15) and patients using the CIVCO immobilization system (n=21). A total of 911 sets of Megavoltage Computed Tomography (MVCT) images were obtained. Prior to each daily treatment, a set of MVCT images was acquired and fused with the planning CT Images. From the image registration result, the detected setup corrections of three translational deviations (longitudinal, vertical and lateral) and the roll rotational deviations were recorded and analyzed. Systematic errors, random errors, and 3D vectors were calculated and compared between the two immobilization systems. The sizes of the clinical target volume-planning target volume (CTV-PTV) margins were also determined from the calculated systematic errors and random errors.

**Results:** Calculated systematic errors, random errors, 3D vectors and CTV-PTV margins were demonstrated in Table 1. No significant difference was identified between the calculated systematic errors of Orfit and CIVCO immobilization systems (p>0.05). Orfit immobilization system had a significantly smaller random errors in the translation deviations of lateral, longitudinal and vertical directions with the differences of 0.3mm, 0.5mm and 0.1mm respectively (p<0.05).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Orfit</th>
<th>CIVCO</th>
</tr>
</thead>
<tbody>
<tr>
<td>LR (mm)</td>
<td>0.3 ± 0.1</td>
<td>0.5 ± 0.2</td>
</tr>
<tr>
<td>AP (mm)</td>
<td>0.5 ± 0.3</td>
<td>0.7 ± 0.4</td>
</tr>
<tr>
<td>Vertical (mm)</td>
<td>0.1 ± 0.05</td>
<td>0.2 ± 0.1</td>
</tr>
<tr>
<td>Roll (degree)</td>
<td>0.7 ± 0.3</td>
<td>1.1 ± 0.5</td>
</tr>
<tr>
<td>CTV-PTV margin (lat)</td>
<td>2.4 ± 0.3</td>
<td>2.7 ± 0.4</td>
</tr>
<tr>
<td>CTV-PTV margin (lng)</td>
<td>3.7 ± 0.5</td>
<td>4.0 ± 0.6</td>
</tr>
<tr>
<td>CTV-PTV margin (vrt)</td>
<td>3.6 ± 0.4</td>
<td>3.9 ± 0.5</td>
</tr>
</tbody>
</table>

**Conclusions:** The correct isocenter repositioning of TMI-TMLI patients is fundamental, in particular in CC direction. A dedicated immobilization system was developed in our center to best immobilize the patient.
Results: The tumour volume, assessed at the planning CT scan, had a median of 26.9 ml range: 0.6-527.8 ml. At the 1.-30fr the tumour change between the visual and algorithm assessment obtained a 82%-92% agreement (mean ± SD: 0.65 ± 0.94). At the 30.3fr the tumour change between the visual and doctor assessment had an 89% agreement (k=0.70). Tumour shrinkage was observed in 12pts.

Furthermore, at the 30.3fr, there was no statistically significant difference between the tumour-change assessment of the doctor (mean ± 1SD: 19.6 ± 36.5ml) and the algorithm (mean: 19.6, 95%CI:10.5-36.5ml), p=0.85. At the 30.3fr there was an 89% (24pts) observed agreement between the three methods. Overall only 1pt had tumour growth >5ml.

Conclusions: The intra-tester reproducibility of tumour-change between the three methods is good. The visual, doctor and algorithm assessments had an agreement of 89%. There was no statistically significant difference between the tumour-change assessment of the doctor and the algorithm. Visual inspection may be used to determine tumour shrinkage during the radiotherapy course.

OC-0072 Development and implementation of a non-invasive stereotactic head frame

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Purpose/Objective: To develop and implement a non-invasive head frame for intracranial stereotactic radiotherapy (SRT). While maintaining and improving treatment accuracy it was important to make the new SRT/SRS frame more efficient, more comfortable for the patients and easier to use for the therapists. We analyzed set up accuracy and intra-fractional motion of the new frame (Civco Medical systems) in comparison to the currently used system (Brainlab).

Materials and Methods: Twenty patients (140 fractions) were treated with the Civco SRS frame, 19 Patients (152 fractions) were treated with the Brainlab system. The Civco frame contains no metal parts making it MRI compatible. Additionally, it allows for better gantry clearance compared to the Brainlab system. Patients were treated either using a VMAT or IMRT technique. Image guidance was performed using CBCT. All positioning discrepancies were documented including pitch and roll. If pitch or roll was greater than 1.5° patient setup was repeated. Translational and rotational errors were corrected daily. A post treatment CBCT was acquired to analyse intra-fractional motion with the CIVCO frame undergoing head and neck radiotherapy.

Results: The setup based on lasers and isocenter marks on the mask is equally accurate in both systems with an accuracy of approximately 2 mm. The uncertainty in longitudinal direction is slightly reduced with the Civco system compared to the Brainlab system. Analysis of the CBCTs showed an increased roll for the patients being fixed with the Civco system (CIVCO: -0.14° ± 1.40°, Brainlab: -0.02° ± 0.02°). The latter is due to an increased frequency of patient res-sets due to the value outside tolerance. The intra-fractional motion was small and comparable between both systems in lateral and longitudinal direction, but was significantly larger for the Brainlab system in vertical direction (CIVCO: -0.02 (±0.23) mm, Brainlab: VRT: -0.21 (±0.31) mm, p<0.01). The observed systematic shift of the Brainlab mask in vertical direction is likely related to the sagging of the patient.

Conclusions: Intra-fractional motion with the Civco frame proved to be slightly less than with the Brainlab system while the pitch and roll deviations in initial setup proved to be marginally larger. Pitch and roll can be corrected easily with a 6 DOF table or by repositioning the patient. Future studies will include frame efficacy, handling and patient comfort.

OC-0073 A comparative study of four commercial thermoplastic masks used in head and neck radiotherapy.

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Purpose/Objective: The aim of this study is to compare four different 5-point fixation commercial thermoplastic masks (A, B, C and D) in combination with two different kinds of head supports (a and b) and thereby verify which combination has less margin of error to get the best immobilisation system.

Materials and Methods: 34 patients with head and neck cancer were treated by using Intensity Modulated Radiotherapy (IMRT) and Rapid Arc (CIRR) therapy on a Varian linear accelerator with an On Board Imagcr (OBI) system. All patients had Image Guided Radiotherapy (IGRT) using kilovoltage (KV) and megavoltage (MV) images at fractions 1-2-3 and then weekly once the systematic errors had been corrected and the random errors were within departmental tolerances. In total 505 images were evaluated. The MV and KV images were compared with Digital Reconstructed Radiographs (DRR) to define the patient translation in the vertical (anterior-posterior), longitudinal (cranial-caudal) and lateral (right-left) axis. Using these measurements, we calculated for each group the systematic (Δyst) and random error (oranndom).

To determine if there was a statistical significant difference between the different masks within one head support group, we used the Kruskal-Wallis ANOVA test. For the difference between the same type of mask but with different head supports, we used the Mann-Whitney U test.

Results: Evaluation of the 5-point thermoplastic fixation mask and head support (values are in centimeters).

<table>
<thead>
<tr>
<th>Head support</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patient</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Number of sessions</td>
<td>45</td>
<td>52</td>
</tr>
<tr>
<td>A,B,C,D</td>
<td>45</td>
<td>52</td>
</tr>
</tbody>
</table>

Mask A was stopped after four patients, because there were difficulties modulating and removing the mask from the patient's head. For this reason no patients were included with this mask and head support b.

Conclusions: The study showed us that there is no statistical significant difference in systematic and random error between mask A,B,C and D. There is also no statistical significant difference between the two head supports, but all systematic and random errors for head support b are equal lower than for head support a.

OC-0074 Radiation therapist led quality assurance of a CT-MRI SIM localisation protocol for patients undergoing H&N RT

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1Hamad Medical Corporation, Radiation Oncology, Doha, Qatar

Purpose/Objective: To assess the geometric accuracy, image quality and a precision of image registration of a new CT/MR image registration. This retrospective quality assurance study is an RT-led review of the CT-MRI SIM localisation protocol for patients undergoing head and neck radiotherapy.

Materials and Methods: At our institution, Radiation Therapists routinely perform treatment planning CT and MRI scans, as well as CT-MR image registration. This retrospective quality assurance study was an RT-led review of the CT-MRI SIM localisation protocol for patients undergoing head and neck radiotherapy. T1/T2 FSE MR-SIM images from the base of brain to below the clavicles, fused with a planning CT were re-reviewed for twenty patients immobilized using the MR-compatible Type-S frame undergoing head and neck radiotherapy.

Results: We performed multiple local registrations (superiorly, mid and inferiorly) fusion was assessed for different levels of the head and neck, by Routinely perform treatment planning CT and MRI scans, as well as CT-MR image registration. This retrospective quality assurance study is an RT-led review of the CT-MRI SIM localisation protocol for patients undergoing head and neck radiotherapy. T1/T2 FSE MR-SIM images from the base of brain to below the clavicles, fused with a planning CT were re-reviewed for twenty patients immobilized using the MR-compatible Type-S frame undergoing head and neck radiotherapy.

Conclusions: The study showed us that there is no statistical significant difference in systematic and random error between mask A,B,C and D. There is also no statistical significant difference between the two head supports, but all systematic and random errors for head support b are equal lower than for head support a.