Interestingly, we can use the backscattering effect to enhance the dose homogeneity in the target volume and a theoretical shield design will be presented.

Figure 1: PDD & Profile measured curves and MC simulation

Figure 2: Dose map for a Mobetron 12 MeV Beam, 5.5 cm Applicator and (Al/Pb) shield plate in water phantom

Conclusions:
- All of the studied shielding plates are clinically acceptable. Normally, the surgeon would prefer the thinnest shield (Al/Pb).
- The good alignment of the applicator and the shield is a key issue

EP-1566
Analysis of the different dose-volume constraints in 3D-CRT breast cancer
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Purpose/Objective: Recent studies have warned about late toxicity, primarily cardiac toxicity, in patients diagnosed with breast cancer who have received radiation therapy. Although there are numerous publications and protocols there is no uniform recommendations for 3D radiation therapy for breast cancer about which are the best dose/volume constraints to evaluate this treatment.

The purpose of this study is to quantify and compare different dose/volume constraints for the organs at risk (OARs) in breast cancer treatment based in the DVH of each study, in order to establish the most useful parameters to evaluate this type of treatment in our institution.

Materials and Methods: 544 women were evaluated. Studies were grouped regarding the type of treatment (breast/chest wall, breast + boost, breast + regional nodal irradiation (RNI), breast+boost+RNI) and the fractionation scheme (2Gy or 2.66Gy per fraction).

Different dose/volume constraints for the heart and lung have been evaluated for each patient (Table 1).

Also, for each patient the clinical pathology before and after the treatment has been evaluated.

<table>
<thead>
<tr>
<th></th>
<th>Ordinary fractionation (2.00Gy/fx)</th>
<th>Hypofractionated (2.66Gy/fx)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart</td>
<td>V_{30Gy}&lt;30cc, V_{50Gy}&lt;10%, V_{250Gy}&lt;10%, V_{450Gy}&lt;3%</td>
<td>V_{54Gy}&lt;30cc, V_{150Gy}&lt;10%, V_{30Gy}&lt;10%, V_{120Gy}&lt;3%</td>
</tr>
<tr>
<td>Ipsilateral lung</td>
<td>V_{30Gy}&lt;200cc, V_{30Gy}&lt;25%, V_{450Gy}&lt;33%, D_{mean}&lt;17Gy</td>
<td>V_{54Gy}&lt;200cc, V_{150Gy}&lt;25%, V_{30Gy}&lt;33%, D_{mean}&lt;17Gy</td>
</tr>
<tr>
<td>Both lungs</td>
<td>V_{30Gy}&lt;25%</td>
<td>V_{160Gy}&lt;25%</td>
</tr>
</tbody>
</table>

Results: From 544 patients only 2 developed symptomatic pulmonary complications and 4 patients developed cardiac complications probably related with the radiotherapy treatment.

Regarding the dose/volume constraints:
- For both lungs, V_{20Gy}(16Gy*)<25% is achieved in about 97% of the patients.
- For the ipsilateral lung, Dmean<17 Gy is achieved in more than 95% of the patients, except in treatments which includes the RNI, where only 64% meet the criteria. Furthermore, the criteria V_{30Gy}<200cc is only achieved by 33% of the patients, in the best situation (breast/chest wall hypofractionated) meanwhile for treatments which includes RNI only 9% meet the objective. For V_{20Gy}<25% the results are in same direction as V_{30Gy}<200cc.
- For the heart, V_{30Gy}(24Gy*)<30 cc is achieved by 29% of the patients in the best situation. V_{20Gy}<10%, V_{40Gy}<5% and V_{25Gy}<10% is achieved by 45%, 41.4% and 52% in the best situations, meanwhile V_{45Gy}<50% and V_{60Gy}<30% is achieved by 100%.

(*) value for hypofractionated treatments

Conclusions: The type of treatment have a big influence in the percentage of cases that meet the dose/volume constraints. Treatments which include the RNI have a low percentage of achievements.

According to our data, we can conclude that the V30(24)Gy<30cc for the heart and the V30(24)Gy<200cc for the ipsilateral lung are quite ambitious constraints and presents a strong dependency of the appearance of the RNI. Also, parameters as the V45Gy<33%, for the ipsilateral lung and V45Gy<50% for the heart, are very relaxed and the achievement of these constraints doesn’t mean that the plan would be an optimal plan.
Finally, we strongly recommend to develop a different set of dose/volume constraints for cases that include the RNI.

**EP-1567**

**A Hybrid IMRT/VMAT technique for the treatment of non-small cell lung cancer**

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**Purpose/Objective:** To investigate a Hybrid IMRT/VMAT technique which combines intensity modulated radiation therapy (IMRT) and volumetric modulated arc therapy (VMAT) for the treatment of non-small cell lung cancer (NSCLC).

**Materials and Methods:** Two partial arcs VMAT, 5-field IMRT and Hybrid IMRT/VMAT plans were created for 15 patients with NSCLC. The Hybrid IMRT/VMAT plans were combination of 2 partial arcs VMAT and 5-field IMRT. The dose distribution of planning target volume (PTV) and organs at risk (OARs) for Hybrid IMRT/VMAT was compared with IMRT and VMAT. The monitor units (MUs) and treatment delivery time were also evaluated.

**Results:** Hybrid IMRT/VMAT significantly improved the target conformity and homogeneity compared with IMRT and VMAT. The V30 of normal lung for hybrid plans was significantly lower than IMRT plans (17.7% vs 18.7%; p<0.05) and VMAT plans (17.7% vs 18.4%; p<0.05). The V5, V10, V30 and mean lung dose (MLD) of normal lung for hybrid plans were 5.1%, 7.7%, 3.8% and 3.9% lower than those for VMAT plans, respectively (p<0.05). The maximum dose of spinal cord for hybrid plans was 5.6 Gy lower than that for IMRT plans (p<0.05). The dose received by esophagus and heart for hybrid plans were significantly lower than those for IMRT plans. The mean delivery time of IMRT, VMAT and hybrid plans were 280 s, 114 s, and 327 s, respectively. The mean MUs needed for IMRT, VMAT and hybrid plans were 933, 512, and 737, respectively.

**Conclusions:** The Hybrid IMRT/VMAT technique significantly improved the target conformity and homogeneity compared with IMRT and VMAT. It reduced V5, V10, V30 and MLD of normal lung compared with VMAT, and protected the OARs better with fewer MUs compared with IMRT. Hybrid IMRT/VMAT technique can be a viable radiotherapy technique with better plan quality.

**EP-1568**

**Increased patient comfort for generating moulds using a 3D printer**

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**Purpose/Objective:** To compensate for the irregular surface of a patient's head custom bolus is often used to get an acceptable dose distribution. This bolus is created on top of a model of the patient's head. The current method is to create a mold with plaster cast. This mold is then filled with liquid plaster to create a model of the patient's face. This procedure is, in terms of required time and comfort, not patient friendly. With the novel imaging method presented here, a digital model of the patient's face is created with a real-time 3D Kinect camera within a minute without touching the patient. This 3D model is printed with a 3D printer. On top of this printed mold the bolus can be constructed as usual. This 3D scanning method is compared with the traditional procedure.

**Materials and Methods:** The 3D digital model is acquired with a Microsoft Kinect camera (Xbox 360 Kinect Sensor) connected to a high end PC (Intel i7-4770 3.4 GHz, 16GB RAM, Radeon R9 200). The acquisition software (Kinect Fusion Explorer) provides 3D object scanning. The resulting reconstructed 3D model of the patients head is cropped and further prepared with in-house developed software. Finally it is printed using Polylactide (PLA) in a 1:1 scale, with a 3D printer (Orange-A420 dual extruder, 3D printservice Arnhem, NL).

To evaluate the procedure we created models using the traditional method and the 3D printer method of the same patient. On top of both models a bolus is constructed. Two CT scans are acquired for this patient using the two created boluses.

**Results:**

Within a minute a digital 3D model is created of the patients head. Directly after the imaging procedure the patient can leave. The figure shows the 3D printed face model on the right. Printing takes about 5 hours depending on the size of the model, layer thickness and infill percentage. This is done at night, no Radiotherapy Technician (RTT) has to be present. The traditional mold on the left was generated in 2 hours in total.

The bolus constructed on the 3D printed model fits better to the patient then the traditional method. Smaller air caps were observed. Without any physical contact the patient is more relaxed. No construction material is used that can deform the shape of the patients face. Printing the model...