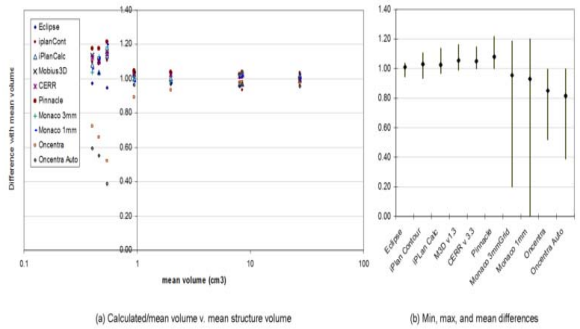
below 1 cm^3. Some TPS shows differences in volume calculation between contour and calculation modules (iPlan, Oncentra, Monaco) and Elekta Oncentra have the highest differences compared with the others TPSs. Monaco losses some very small structure (<0.3 cm^3) when importing contours. In figure 1b it is shown minimum, maximum and mean differences of every TPS versus mean reference volume for all structure studied.



Conclusions: It is necessary to study and QA volume reconstruction algorithm of TPSs before starting an SRS/SBRT program. Specific tests for small volumes below 1 cm^3 have to be made and developed.

EP-1456

On the dosimetric impact of virtual material assignment to the ArcCHECK phantom for quality control with Acuros XB

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Purpose/Objective: Acuros XB® is a recent advanced algorithm for photon dose calculation. Similarly to Monte Carlo simulations, AXB calculates doses using proper media cross section. The aim of this study was to investigate AXB capacity to correctly account for a virtual material assignment for patient QA in ArcCHECK® diode array (AK).

Materials and Methods: Relative differences were estimated between calculations and measurements in function of the virtual material assigned to the AK. The following virtual materials were studied by scaling CT number to reach AK relative electron density or mass density: human tissues obtained by default on the phantom CT scan, physical material and water. In addition, Anisotropic Analytical Algorithm (AAA) and AXB results were compared. Parametric studies were done in isocentric conditions by varying scatter conditions. Prostate and endometrial patient treatment cases were studied in the AK using ionization chamber (IC), Gafchromic films and diodes measurements.

Results: Regarding the open field tests, ionization chamber measurements at isocenter have shown relative differences of 1.5+/-0.3% using PMMA and -1.2+/-0.3% using the default material (cartilage) each time in combination with a scaled CT number to the AK's mass density. In the cases of water scaled to mass and relative electron density, results have been higher: -2.8+/-0.4% and -3.4+/-0.5%. Regarding the patient treatment studied cases, the best results for ionization measurements were obtained with AXB using the cartilage (with CT numbers adapted to mass density) and PMMA materials. No significant differences were obtained with diode pass rates. Gafchromic films have given interesting results and showed for prostate cancer treatment plans better dose estimation with PMMA material (figure 1).

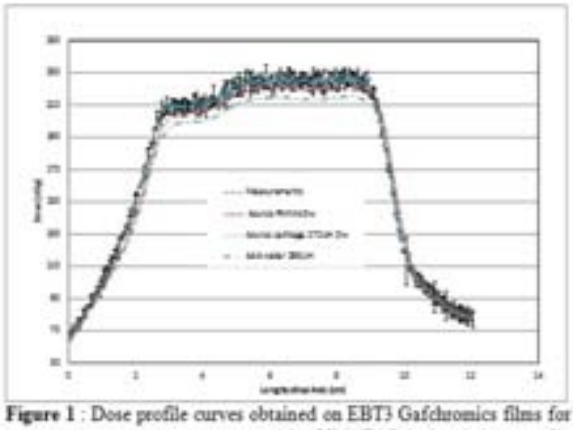

Figure 1 : Dose profile curves obtained on EBT3 Gafchromics films for a prostate cancer treatment treated by VMAT. Calculated dose profile curves obtained with AAA and AXB are superimposed in function of the virtual AK material assignment.

Conclusions: Phantom CT numbers have to be adjusted to mass density for advanced algorithms such as AXB and to relative electron density for conventional algorithms such as AAA. Better results are observed if right physical materials are applied to the virtual phantom images (PMMA for the ArcCHECK phantom). This study leads to state that a particular attention should be paid to QA phantom commissioning in the TPS for advanced algorithm such as AXB.

EP-1457

VMAT with Simultaneous Integrated Boost in head-and-neck cancer: a dosimetric study aiming to reduce dysphagia

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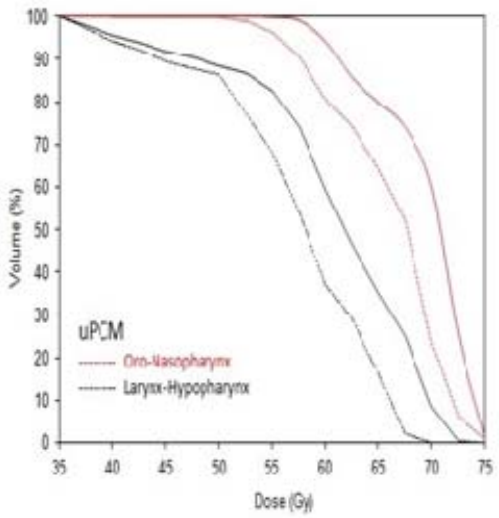
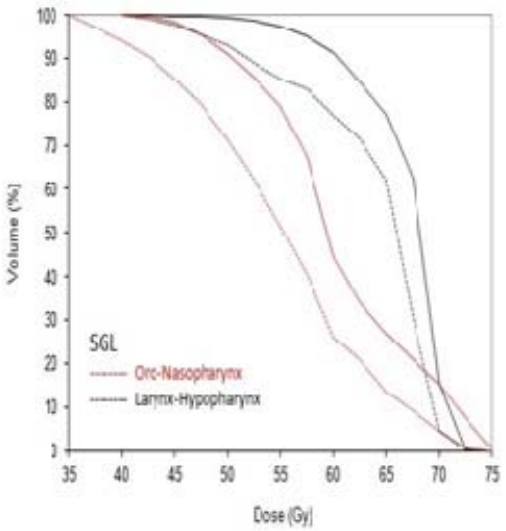
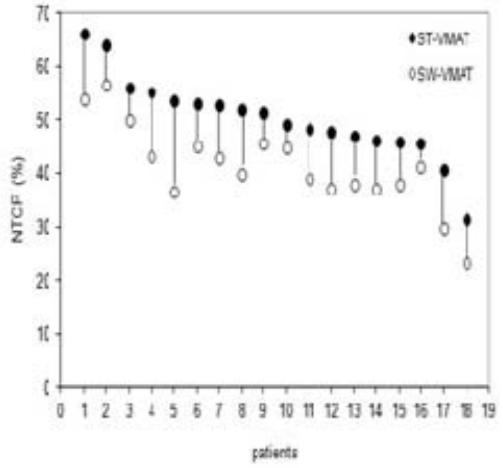
Purpose/Objective: Dysphagia is one of the most disabling complications associated with head-neck chemo-radiotherapy intensification. Pharyngeal constrictor muscles (PCM) and supraglottic larynx (SGL) have been identified as principal organs in which swallowing dysfunction after chemo-radiation causes dysphagia. If significant correlations between dysphagia and increased doses to PCM and SGL are now established, dose sparing of swallowing structures still represents a major challenge in HN planning optimization process. In this study, we explored the potential of VMAT technique to reduce the risk on swallowing problems after curative chemo-radiotherapy.

Materials and Methods: Eighteen head-and-neck cancer patients who previously underwent radiotherapy for the bilateral neck were selected. Radiotherapy was prescribed according to Simultaneous Integrated Boost technique with all PTVs irradiated simultaneously over 30 daily fractions. Doses of 70.5, 60.0 and 55.5 Gy were prescribed to CTV1 (primary tumor), CTV2 (high-risk nodal regions) and CTV3 (low-risk nodal regions). Clinical dual-arc VMAT plans (ST-VMAT) were originally created with Masterplan Oncentra TPS. For each patient, a new plan (SW-VMAT) based on the approved ST-VMAT plan was created. PCM and SGL were considered OARs related to swallowing dysfunction (SW-OARs). Upper (uPCM), middle (mPCM) and lower (lPCM) part of PCM were outlined separately. All objectives for PTVs coverage and non related swallowing OARs ((NSW-OARs: parotids, eyes, lens, optic chiasm, brainstem, optic nerves) sparing were left unchanged. New objectives were added for SW-OARs, with priority to minimize mean doses to uPCM and SGL. NTCP for physician-rated swallowing dysfunction was calculated using the recently predictive model by Christianen et al (MEMC Christianen et al. Radioth Oncol 105 (2012) 107–114). The Wilcoxon signed-rank test was used to compare the two optimization techniques.

Results: For all plans targets coverage was well within the predefined objectives, with at least 98% of PTVs receiving 95% of prescribed doses. SW-VMAT plans showed slight increased dose inhomogeneity. No differences were found in sparing of parotid glands for ST-VMAT and SW-VMAT. No significant differences were found for all others NSW-OARs. For PCM and SGL, mean doses, V_{60} and V_{65} were lowest with SW-VMAT plans. Mean doses for uPCM and SGL were reduced by 3.7 Gy and 4.6 Gy, respectively; V_{60} decreased from 82% to 65% for uPCM and from 63% to 46% for SGL. The mean reduction of NTCP-values for RTOG grade 2–4 swallowing dysfunction was 9.2% (range, 4.4–16.9%). Dose reductions with SW-VMAT widely varied among patients and depend on tumor location and overlap with SW-OARs (figure 1).







Mean DVH for uPCM (a) and SGL (b) according to tumor location; solid lines (ST-VMAT) and dotted line (SW-VMAT). NTCP: values (:) for RTOG grade2-4 swallowing dysfunction.

Conclusions: SW-VMAT plans aiming at sparing swallowing structures are feasible, with the potential to reduce NTCP swallowing dysfunction with respect to conventional ST-VMAT.

EP-1458

Proton breast treatments: eclipse vs Monte Carlo Fluka dose comparison study

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Purpose/Objective: We present a Fluka Monte Carlo (MC) simulation study for proton treatments based on Varian Eclipse proton plans for left breast cancers including the internal mammary chain. Doses calculated in TPSs are usually accurate within the primary field, but less accurate outside. With the MC treatment verification we can not only find possible inaccuracies in the delivered dose to the regions of main interest (PTV and OAR like heart and left lung) mainly due to body inhomogeneities close to the PTV (i.e., ribs and lung), but also find the accurate dose deposited in other healthy tissues not included in the TPS optimisation (contra lateral lung, contra lateral breast). Doses deposited by other particles not generated in the TPS, but usually created during a real treatment, such as neutrons and light ions, are also accounded for in the MC. All of this allows us to more accurately determine toxicity to healthy tissues and risk of secondary malignancies.
Materials and Methods: Before starting any comparison between the MC and the TPS, the virtual CAP GENERAL machine used in the proton Eclipse TPS had to be accurately characterised. In this context studies were performed using virtual water phantoms to determine the beam characteristics (energy, energy spread, spatial spread) and so to prove the equivalence of Eclipse plans in Fluka. Eighteen different patient plans for breast treatments were then performed using Eclipse and the information about the used beams included in the TPS RTPLAN files were extracted and converted to plans in Fluka. This allowed us to perform dose comparisons between plans and simulations in the entire upper body of the patient.
Results: In this work we developed a method of performing treatment verification of Eclipse breast plans with the Monte Carlo Fluka and show that dose differences up to 4% in the PTV and up to 70% in other healthy tissues (i.e., contra lateral breast) can be observed when the TPS plans are compared with Fluka simulations of the same plans.
Conclusions: While the Varian TPS for conventional radiotherapy is widely used, the proton Eclipse TPS is only used in a few facilities, resulting in a dearth of comparison studies. In particular breast treatments with protons are in the early stages of investigation and not many groups so far have demonstrated the accuracy of TPSs with respect to this treatment site. With this study we demonstrate that treatment verification with Monte Carlo simulations is essential to better determine the dose deposited in the entire patient body, and in particular to the healthy tissues.

EP-1459

Dosimetric evaluation of arc-based modulated electron radiation therapy

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Purpose/Objective: To perform a dosimetric evaluation of arc-based modulated electron radiation therapy (arc-MERT) using a direct aperture optimization (DAO) algorithm.
Materials and Methods: An arc-MERT plan was mimicked by setting a series of field ports with small angle increments (between 6° and 15° depending on the case). When possible, a single isocenter was used for the field set-up; this was not always possible due to the short source-to-skin distance (~70cm) used for MERT planning using the photon MLC for beam collimation. For each field port, beamlet dose distributions were generated for several different electron beam energies. A treatment plan is created by selecting and optimizing the shape and the weight of a certain number of initial apertures per beam energy and per field. Thus, different combinations of apertures can be investigated with the available field ports and beam energies. This approach was applied for two clinically motivated situations: a head and neck and a breast case. For the head and neck case, 13 field ports spanning a 140° arc were set up using multiple isocenters. For the breast case, 6 field ports spanning a 30° arc were set up using a single isocenter. For both cases, many plans were generated using different combinations of apertures (between 10 and 90 apertures per plan). The dose homogeneity to the PTV as well as the doses to organs at risk (OAR) were determined and compared to photon plans.
Results: Using arc-MERT, it is possible to achieve a high dose homogeneity to the PTV (V95%-V107% > 95%), which is similar to the photon plan. Good treatment plans can already be achieved using between 30 to 50 apertures and more than one electron beam energy. For the head and neck case, the organs at risk sparing was similar to the original VMAT plan, while the low dose bath could be substantially reduced with arc-MERT (V10% = 554 cc versus 1150 cc for VMAT). For the breast case, the high dose homogeneity to the PTV achieved with arc-MERT came at the cost of high ipsilateral lung doses (mean dose 20 Gy, V30Gy = 34%). If the CTV had to be adequately covered instead of the PTV (defined for tangential photon plans), the doses to the ipsilateral lung could be substantially reduced (mean dose 7.3 Gy, V30Gy=1%).
Conclusions: arc-MERT offers the potential to achieve high dose homogeneity to the PTV similar to photon plans and depending on the case also similar OAR sparing while reducing the low dose bath. More work is required to define which sites would most benefit from arc-MERT. This work is supported by the Swiss Cancer Research grant KFS-3279-08-2013.