

recurred and previously radiated digestive tumors. This treatment offers adequate locoregional control with acceptable range of complications.

#### Electronic Poster: Brachytherapy track: Miscellaneous

##### EP-2015

Acute toxicity in HDR BT of skin cancer with very high viscosity addition silicone custom made molds

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**Purpose or Objective:** To study normal skin acute toxicity in Non-Melanoma Skin Cancer (NMSC) patients treated with High Dose Rate (HDR) Plesiotherapy and very high viscosity addition silicone (VHVAS) rubber custom-made molds. VHVAS rubber features excellent mechanical and physical properties which benefit the stability and reproducibility of the implant. On the other hand, the high electron density relative to water of these materials will increase the scatter production, which may be relevant at the mold-skin interface.

**Material and Methods:** Our standard applicators are polymerized VHVAS molds with catheters embedded. This VHVAS model features 99.5% recovery factor after compression and maximum 0.20% linear dimensional variations. Dosimetric properties of this VHVAS have been characterized by our Group elsewhere. Silicone attenuation relative to water is <5% up to 3 mm thickness. Maximum scatter relative to water measured at the mold interface is <14%. Treatment is delivered with a Ir-192 based VARIAN MS Gammamed+ HDR unit. All treatments are 3D simulated. A sample of 15 Patients with 21 lesions (8 basal cell carcinomas, 13 squamous cell carcinomas) representing all treated locations were considered. Average age is 83.1 years [96-58], 47% without any concomitant diseases and life expectancy >5 years. Median lesion area is 5.4 cm<sup>2</sup> [1.0-46.6], treatment depth is 4.0 mm [2-15] and microscopic disease margin is 4 mm [2-5]. Standard fractionation is 5.5 Gy/fr, 10-12 fr, twice a week. Acute toxicity was retrospectively assessed following the RTOG criteria.

**Results:** DVH analysis showed high dose areas having: D1cc=8.5 Gy/fr [5.4-14.4], D0.5cc= 9.0 Gy/fr [5.4-16.3], D0.1cc= 10.3 Gy/fr [6.2-22.9]. All patients presented radiodermatitis 1 month after treatment (G2: 89%, G3: 11%). 32% presented radiodermatitis at 3 months (G1: 26%, G2: 6%) and only one patient presented radiodermatitis G1 at 6 months. Toxicity score correlation to CTV volume, treatment depth, BED prescribed dose, D1cc, D0.5cc and D0,1cc had no statistical significance ( $p>0.05$ ). Treated area was found to be predictive of radiodermatitis persistence at 3 months after treatment ( $p=0.036$ ). Lesions located in the legs showed longer recovery time from radiodermatitis than other locations (4 months vs 1.8 months average).

**Conclusion:** The use of these VHVAS moulds was well-tolerated by all patients. Our treatments yield similar results to other groups with similar treatment schemes in terms of acute toxicity. We can conclude that VHVAS custom made molds have a good safety profile.

##### EP-2016

A method to transform 2D LDR brachytherapy plans into contemporary 3D PDR dose distributions

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**Purpose or Objective:** Formerly in the 2D Low-Dose Rate (LDR) era no information about Dose-Volume Histogram (DVH) parameters of organs at risk (OARs) was available in

brachytherapy plans. To enable research on late dose effects for children treated with Pulsed-Dose Rate (PDR), 3D dose distributions and DVH parameters are required. In this study a method was developed to enable calculation of DVH parameters.

**Material and Methods:** Before 2001 pediatric head and neck (H&N) patients received LDR brachytherapy as a part of their treatment. Of 16 LDR plans (1989-2001) only hard-copy CT data, orthogonal x-ray images of the implant and documented 2D dose information were available. The documented 2D dose information consisted of source strength, catheter numbering, catheter loading, and treatment time. The hard-copy CT data was digitized, transferred to DICOM format and imported in Oncentra Brachy (Elekta, v4.3). The visible OARs were delineated and used catheters were reconstructed. The Ir192-LDR line sources from the original 2D plans were simulated by loading the reconstructed catheters with Ir192-PDR source tracks of the same length as the LDR sources, with a step size of 2.5mm. Simulation of a line source dosimetry was necessary because the planning system did not support LDR planning. All PDR source dwell times were made equal, but scaled to the documented 2D dose distribution to obtain the 3D dose distribution at time of treatment. Scaling was performed at a 2D LDR isodose level below 30% of the prescribed dose in a plane where the documented 2D dose distribution and transformed 3D dose distribution geometrically match. Scaling below 30% is done to avoid effects due to the non-uniform isodose distribution very close to a stepping PDR source. To check the reliability of the method the Total Reference Air Kerma (TRAK) for both 2D LDR and 3D PDR plans were determined and compared. The difference was tested with the Wilcoxon Signed Rank Test for paired variables. To illustrate the applicability of the method the maximum dose, defined as the D0.1cm<sup>3</sup>, on e.g. chiasm was determined.

**Results:** Of 16 LDR plans 2D data were transformed into 3D dose distributions. OARs and DVH parameters of chiasm were determined. The mean 2D TRAK was 0.95cGy/1m (IQR 0.89). The mean 3D TRAK was 0.89cGy/1m (IQR 0.74). The mean difference of 2D TRAK and 3D TRAK was statistically not-significantly different from 0 ( $P=0.45$ ). For 7 patients the CT data incorporated the chiasm area. The mean chiasm maximum dose was 233.6cGy (range 4.6-399.2) using the described method.

**Conclusion:** With the described method it was possible to transform 2D LDR brachytherapy plans into a 3D dose distribution. This method shows the possibility to use information from 2D LDR brachytherapy plans in scientific studies in which 3D dose information is needed.

##### EP-2017

High dose-rate endoluminal brachytherapy as a treatment of primary and recurrent esophageal cancer

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**Purpose or Objective:** To evaluate outcomes and toxicities after high dose-rate (HDR) endoluminal brachytherapy for the treatment of esophageal cancer patients.

**Material and Methods:** We analyzed the patient records of 36 patients treated with high dose-rate endoluminal brachytherapy for histologically confirmed esophageal cancer. Brachytherapy was either applied as a boost treatment for definitive radiotherapy and radiochemotherapy regimens or as a salvage treatment for recurrent tumors. Single radiation doses between 4 and 6 Gy were delivered to the endoscopically visible tumor including 2 cm margins in 2 to 4 sessions. Recurrence-free and overall

survival as well as acute and late toxicities were retrospectively analyzed.

**Results:** Brachytherapy was performed as initially planned in all but one patient. 18 patients had a complete endoscopic response at the first follow-up examination. Loco-regional recurrence was observed in 24 patients after a median time of 3 months; 1- and 2-year recurrence-free survival rates were 51% and 51% for the patients treated for primary tumors and 11% and 6% for patients treated for tumor recurrence, respectively. Median overall survival was 18 months; estimated overall survival rates at 1, 2 and 3 years were 63%, 50% and 30% after primary brachytherapy, and 60%, 25% and 6% after treatment for recurrent cancers. Adenocarcinoma histology, non-complete remission after treatment and treatment for recurrent cancers were associated with significantly reduce prognosis. Mild to moderate dysphagia was the most common side effect in 17 patients; 8 patients suffered from loco-regional grade 3 toxicities, and no grade 4 or 5 toxicities were observed.

**Conclusion:** Endoluminal brachytherapy during the course of esophageal cancer treatment can be safely applied and results in good functional outcomes regarding dysphagia with moderate local toxicity and low side effects to the lung and heart.

#### EP-2018

Treatment with high dose rate plesiotherapy and custom moulds in skin cancer. Long term results

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**Purpose or Objective:** To describe the technique used in our department for treatment of cutaneous tumors with HDR plesiotherapy using custom moulds and to analyze long term results.

#### Material and Methods:

Custom made mould fabrication:

We used this applicator in irregular areas of skin.

The treatment sequence is:

- Creation of the mould with thermoplastic material with a thickness of 5 mm.
- Parallel placement of transfer guide tubes with 1 cm of separation.
- CT simulation and definition of the volume treat. The volume has to be delimited 5 mm in deep.
- Dosimetry.
- Treatment of the patient.

We used 3 different schedules:

- 54 Gy in 18 fractions
- 66 Gy in 33 fractions
- 40 Gy in 10 fractions

**Results:** From September 2008 until September 2015 53 patients had been treated with this technique.

The average age was 77 years (63-91), the histology was squamous in 6 cases, basocellular in 46 cases, melanoma in situ in 1 case.

The mean dose was 54.8 Gy (40-66). The treatment was adjuvant after surgery in 41,5% of the patients.

After a mean time of follow up was 34,1 months there were 2 local relapses (3.77%) in the treatment location. No deaths related to disease were observed.

**Conclusion:** Treatment with HDR plesiotherapy using custom moulds is a technique used to treat small lesions and/or irregular surface locations. Planning with CT scan allows to know the dose in organs at risk using dose-volume histogram. This treatment offers a high local control of the disease and can be used alone or as adjuvant treatment after surgery in case of positive margins or presence of adverse factors.

#### EP-2019

The safety and efficacy of external beam radiotherapy combined yttrium 90 SIRT

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**Purpose or Objective:** Previous literatures showed prior liver external beam radiotherapy (EBRT) may increase liver toxicity after yttrium-90 (90Y) selective internal radiation therapy (SIRT). In contrast, the safety of EBRT followed by SIRT is unclear. We investigated the safety and efficacy of EBRT followed by SIRT in hepatocellular carcinoma (HCC) patients.

**Material and Methods:** Between October 2011 and May 2015, a total of 11 HCC patients who had treated with SIRT followed by liver salvage EBRT were enrolled. The SIRT 3-dimensional absorbed dose distribution of each patient was retrospectively calculated on a voxel base, using post-treatment bremsstrahlung SPECT/CT images. The physical dose and biological effective dose (BED) of SIRT and EBRT were generated and summed for evaluation. The dose-volume histograms (DVHs) of the EBRT, SIRT, and combined therapy were analyzed. Liver-related toxicities were collected by chart-review and classified as Common Terminology Criteria for Adverse Events version 4.

**Results:** The median time interval of SIRT and EBRT was 95 days (IQR: 66.5-129.5 days). Eight patients (73%) had undergone EBRT for portal vein thrombosis (PVT) and 6 patients (55%) for residual hepatic tumor. The mean SIRT, EBRT, and combined therapy normal liver BED were 52.1±21.0 Gy, 17.9±6.1 Gy, and 69.5±15.0 Gy, respectively. The summed DVH of each patient is depicted in Figure 1. The image study three months post-irradiation showed primary disease PR in 4 patients (67 %) of patients and thrombosis improved in 6 patients (75%) after EBRT. Two patients had no evidence of disease after combined therapy. The median survival was 359.9 days. Total 3 patient (27 %) had developed ≥grade 2 liver toxicities. Patient who experienced hepatotoxicity had higher summed BED (107.0±7.3 Gy vs 58.9±13.5 Gy; P = 0.02). The univariate analysis of summed DVH showed that the fraction of normal liver exposed to more than 70 Gy (V70) was the strongest predictor of hepatotoxicity (9.4±7.2% vs 29.9±4.4%; P=0.007), as presented in Table 1.

Figure 1: DVH of 11 patients

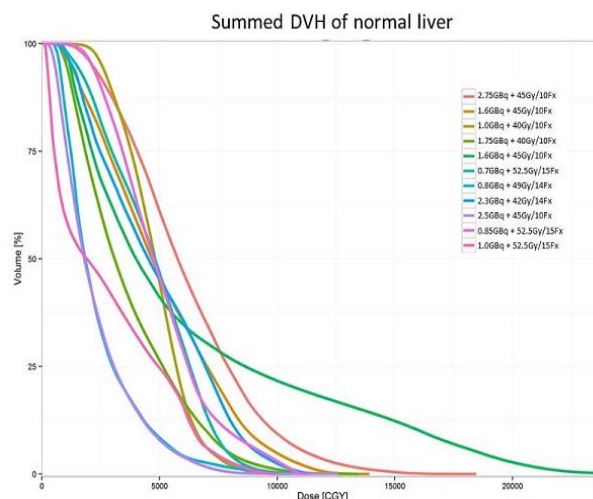


Table 1. Dosimetric parameter univariate analysis