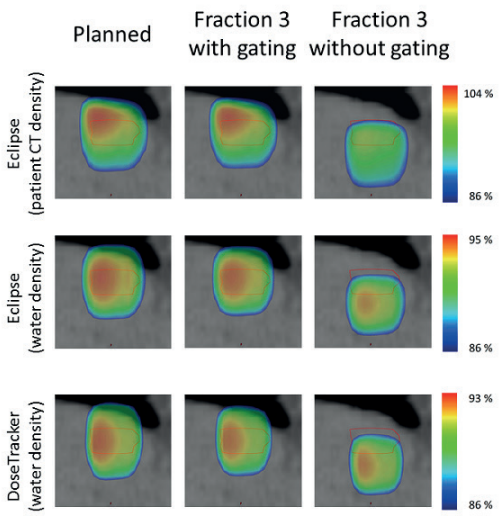

Figure 1: *Reconstructed dose distributions in the coronal plane for the planned static treatment and for the actual gated and simulated non-gated treatment for the fraction with largest motion (Patient 1, fraction 3).*

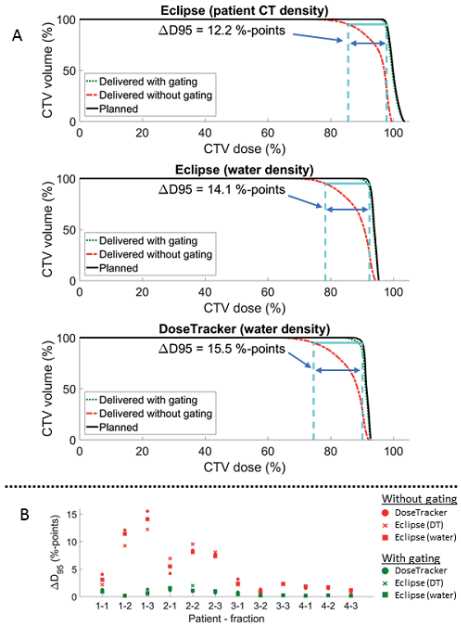

Figure 2: *(A) CTV DVHs for the simulated non-gated treatment for the fraction with largest motion (Patient 1, fraction 3) for dose reconstructions in the TPS (CT density and water density) and in DoseTracker. (B) Motion-induced CTV ΔD95 for all gated (green) and non-gated (red) treatments as determined by the TPS with CT density (crosses), the TPS with water density (squares) and with DoseTracker (circles).*

Conclusion

Real-time dose reconstruction to moving tumours was developed and showed promising results for liver SBRT. The dose reconstruction allows immediate evaluation of the treatment quality. It could, for example, be used to trigger more elaborate dose analysis and plan adaptation in case of large motion-induced dose degradation. Ongoing work will extend DoseTracker with CT heterogeneities and include all 15 patients of the gating study.

OC-0416 Can a consistent dose to the target volume in SBRT be obtained by prescribing on the mean ITV dose?

L. Wilke[1], O. Blanck[2], C. Albrecht[3], Y. Avcu[4], R. Boucenna[5], K. Buchauer[6], T. Etzelstorfer[7], C. Henkenberens[8], D. Jellner[9], K. Jurianz[10], C. Kornhuber[11], S. Lotze[12], K. Meier[13], P. Pemler[14], A. Riegler[15], A. Röser[16], D. Schmidhalter[17], K.H. Spruijt[18], G. Surber[19], V. Vallet[20], R. Wiehle[21], J. Willner[22], P. Winkler[23], A. Wittig[24], C. Moustakis[25]

[1]*Universitätsspital Zürich, Klinik für Radio-Onkologie, Zürich, Switzerland*
[2]*Universitätsklinikum Schleswig-Holstein- Campus Kiel, Klinik für Strahlentherapie, Kiel, Germany*
[3]*Schwarzwald-Baar Klinikum Villingen-Schwenningen, CyberKnife Centrum Süd, Villingen-Schwenningen, Germany*
[4]*Universitätsspital Basel, Klinik für Strahlentherapie und Radioonkologie, Basel, Switzerland*
[5]*Hislanden Lausanne, Institut de radio-oncologie, Lausanne, Switzerland*
[6]*Kantonsspital St. Gallen, Klinik für Radio-Onkologie, St. Gallen, Switzerland*
[7]*Ordensklinikum Linz Barmherzige Schwestern, Radio-Onkologie, Linz, Austria*
[8]*Medizinische Hochschule Hannover, Klinik für Strahlentherapie und Spezielle Onkologie, Hannover, Germany*
[9]*Kantonsspital Luzern, Radio-Onkologie, Luzern, Switzerland*
[10]*Gamma-Knife Zentrum Krefeld, Gamma-Knife Zentrum Krefeld, Krefeld, Germany*
[11]*Universitätsklinikum Halle, Klinik für Strahlentherapie, Halle, Germany*
[12]*Uniklinik RWTH Aachen, Klinik für Radioonkologie und Strahlentherapie, Aachen, Germany*
[13]*Klinikum Wolfsburg, Strahlentherapie, Wolfsburg, Germany*
[14]*Stadtspital Triemli, Klinik für Radioonkologie, Zürich, Switzerland*
[15]*Landesklinikum Wiener Neustadt, Institut für Radioonkologie und Strahlentherapie, Wiener Neustadt, Austria*
[16]*Helios Universitätsklinikum Wuppertal, Strahlentherapie und Radio-Onkologie, Wuppertal, Germany*
[17]*Inselspital Bern, Abteilung für Medizinische Strahlenphysik, Bern, Switzerland*
[18]*Clinique des Grangettes, Institut de radio-oncologie, Geneva, Switzerland*
[19]*CyberKnife Centrum Mitteldeutschland, Institut für Radiochirurgie und Präzisionsbestrahlung, Erfurt, Germany*
[20]*Centre hospitalier universitaire vaudois, Service de radio-oncologie, Lausanne, Switzerland*
[21]*Universitätsklinikum Freiburg, Klinik für Strahlenheilkunde, Freiburg, Germany*
[22]*Klinikum Bayreuth, Klinik für Strahlentherapie, Bayreuth, Germany*
[23]*LKH-Univ. Klinikum Graz, Universitätsklinik für Strahlenterapie-Radioonkologie Graz, Graz, Austria*
[24]*Universitätsklinikum Giessen und Marburg- Philipps-Universität Marburg, Klinik für Strahlentherapie und Radioonkologie, Marburg, Germany*
[25]*Universitätsklinikum Münster, Klinik für Strahlentherapie, Münster, Germany*

Purpose or Objective

Dose fractionation, normalization and the dose profile inside the target volume varies significantly between different institutions and methods for lung SBRT. A comparison of dosimetric as well as outcome data amongst institutions is therefore difficult. Published planning studies have shown that, despite dose prescription on the covering isodose of the PTV, the mean dose in PTV and ITV varied significantly, in

particular when comparing different dose delivery techniques. This multi-center planning study of the DEGRO AG Stereotactic Radiotherapy investigated whether a prescription on the mean ITV dose results in more comparable dose distributions among participating centers and methods.

Material and Methods

CT images and structures of ITV, PTV and all relevant OAR for two patients with early stage NSCLC were sent to all participating institutions. Each institute created a treatment plan with the technique commonly used in the institute for lung SBRT.

The specified dose fractionation was 3x21.5 Gy normalized to the mean ITV dose, this corresponds to 3x15Gy on the 65% isodose. Other constraints on ITV, PTV and OAR are giben in Tab. 1.

constraints for PTV and ITV	constraint	allowed deviation
ITV(0.1cm³)	< 107%	< 110%
ITV coverage V(90%)	> 95%	> 90%
PTV coverage V(70%)	> 95%	> 90%
Conformity index defined as (V70%/V(PTV))	< 1.2	< 1.25
constraints for OAR	**constraint**	
Spinal canal: D(0.1cm³)	< 18 Gy	
Thoratic wall: D(30 Gy) <	< 30 cm³	
Rest	ALARA	

***Tab. 1**: Constraints for ITV, PTV and OAR*

Kruskal-Wallis test was used to compare results for PTV and GTV doses between different delivery techniques.

Results

57 plans from 27 institutions could be collected. These contained 8 Robotic Radiosurgery (RRS), 34 modulated plans (MOD), and 15 3D conformal (3D) plans. Only one plan could not fulfill the given constraints (high conformity index) while in 18 cases there was a minor deviation.

Due to the normalization the mean ITV dose was identical in all cases and the median dose in the ITV varied only marginally (64.1-65.7 Gy). For both patients the median coverage of the ITV with the 90% Isodose was above 98% (94.2-100%).

The median of the mean dose in the PTV did not differ significantly between the two patients (56.9 Gy vs 56.6 Gy). There was only a small difference between the techniques, with RRS having the lowest mean PTV Dose with 55.9 Gy followed by MOD plans with 56.7 Gy and 3D plans with 57.5 Gy having the highest as shown in Fig. 1.

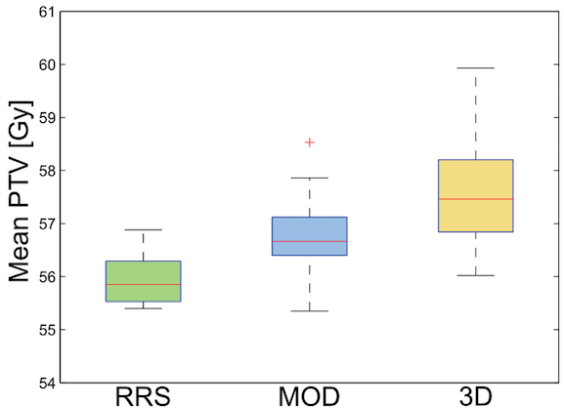

***Fig. 1**: Mean PTV Dose for the three different techniques (both patients combined)*

The Coverage of the PTV with the 70% Isodose (= 45Gy) showed no significant variation between the techniques however it was planner dependent (90-100%), with four plans being below 95% coverage (3 MOD and 1 3D plan).

No significant difference could be found between the conformity indices. It was slightly lower for robotic radiosurgery and modulated plans (median 1.12) than for 3D conformal plans (median 1.18).

For the different organs at risks no significant difference between the techniques could be found.

Conclusion

This planning study showed that normalization on the mean ITV dose in combination with detailed constraints for the PTV and ITV can lead to consistent dose distributions for different delivery techniques. The only significant difference found was the mean PTV dose, but the difference was small.

OC-0417 Random breathing states sampling in a 4D MC dose calculation framework to quantify interplay effects

A. Von Münchow[1], K. Straub[1], C. Losert[1], R. Shpani[1], J. Hofmaier[1,2], P. Freisslederer[1], C. Heinz[1], C. Thieke[1], M. Söhn[1], M. Alber[3,4], R. Floca[4,5], C. Belka[1,6], K. Parodi[2], M. Reiner[1], F. Kamp[1]

[1]*University Hospital - LMU Munich, Department of Radiation Oncology, Munich, Germany*
[2]*Faculty of Physics - Ludwig-Maximilians-Universität München, Department of Medical Physics, Munich, Germany*
[3]*Heidelberg University Hospital, Department of Radiation Oncology, Heidelberg, Germany*
[4]*Heidelberg Institute of Radiation Oncology HIRO, National Center for Radiation Research in Oncology NCRO, Heidelberg, Germany*
[5]*German Cancer Research Center DKFZ, Junior Group Medical Image Computing, Heidelberg, Germany*
[6]*DKTK, German Cancer Consortium, Munich, Germany*

Purpose or Objective

The interplay between respiratory motion of a tumor and dose delivered by complex radiotherapy techniques like VMAT can potentially lead to undesirable and non-intuitive deviations from the planned dose distribution. We developed a 4D dose recalculation framework to precisely simulate the dose distribution for a moving target volume. A wide range of breathing scenarios has to be explored to quantify the plan- and case-specific likelihood of interplay-induced dose deviations. For the assessment of interplay effects we introduce a random breathing states (*rand. breath. states*) assignment based on a subsecond time resolution of the 4D MC dose calculation. The presented and evaluated approach includes a statistical worst-case approximation to all possible breathing curves.

Material and Methods

The developed workflow combines MC dose calculation with Elekta's Delivery Parameter Log Files and dose accumulation based on 4D-CT images. Treatment plan fragments of 0.2s duration are retrieved from linac log data and are forward calculated on ten 4D-CT phases using MCverify/Hyperion V2.4 (research version of Monaco 3.2, Elekta). The resulting dose fragments allow simulation of arbitrary respiratory curves (e.g. different respiration patterns in phase or frequency as well as random breathing states) with a resolution of 0.2s by assigning every fragment to a distinct 4D-CT phase. Based on deformable image registration (plastimatch) the selected dose fragments are accumulated by AVID, a software framework for medical data processing. In addition to the recorded, normalized breathing curve of the patient with random start phases (*rand. start*), a statistical approach is implemented that randomly assigns every 0.2s treatment plan fragment to a 4D-CT phase (*rand. breath. states*).

Results

Fig. 1 shows our *rand. breath. states* approach for an exemplary 3 Gy, VMAT, SBRT treatment of a 9cm³ lung tumor with 1.6cm crano-caudal movement. 128 random