treatment delivery. In the screening procedure, three of the four patients' breathing regularity was improved with AVB. Across a course of SBRT, AVB also demonstrated to improve the regularity of breathing displacement and period over free breathing.This was also the first study to assess the impact of AVB on liver tumor motion via fiducial marker surrogacy. Results from the first four patients have been reported here and demonstrate clinical potential for facilitating regular and consistent breathing motion during CT imaging and treatment delivery.

EP-1743

Analysis of the deviation of lung tumour displacement caused by different breathing patterns

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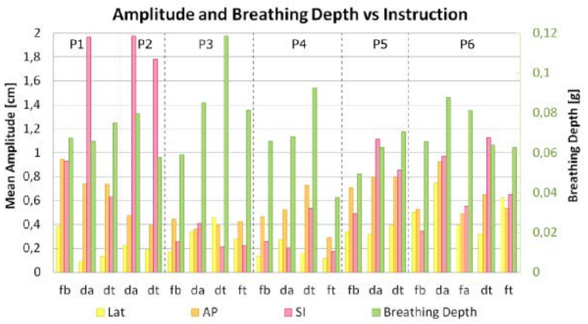
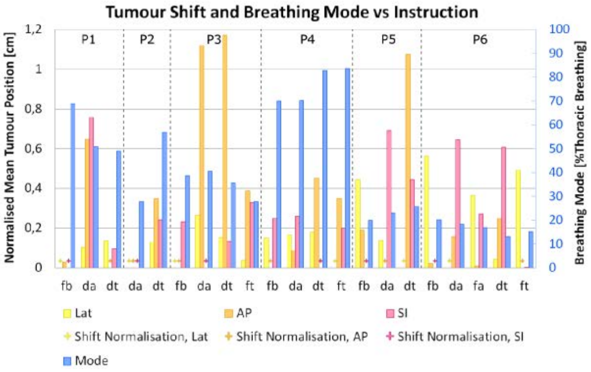
Purpose or Objective: By applying motion correction strategies for the treatment of lung tumours the variability of breathing induced tumour movement is more important. To analyse the different motion potential of lung tumours a clinical trial is carried out. FDG-PET scans are performed simultaneously with an accelerometer-based system, which detects the breathing motion. Specific breathing instructions are given to the patient, to analyse the correlation of the sensor information and the tumour displacement, caused by different breathing patterns.

Material and Methods: The study is performed with patients with a single pulmonary metastasis. For the detection of the breathing motion six tri-axial accelerometers are placed on the patient's thorax and abdomen. Thereby, information on the breathing cycle (in-/expiration), breathing mode (thoracic/abdominal) and breathing depth can be distinguished. Up to five different measurements are obtained: 'free breathing', 'deep thoracic', 'flat thoracic', 'deep abdominal' and 'flat abdominal'. Simultaneously, a respiratory gated FDG-PET scan is taken to correlate the patient's respiratory states with the tumour movement. For each of the ten reconstructed PET images the centre of the tumour is determined to visualize the mean tumour trajectory.

Results:





In the figure the analysis of the reconstructed sensor and PET data is shown for six patients, for each of the different breathing scenarios (fb: free breathing, da: deep abdominal, fa: flat abdominal, dt: deep thoracic, ft: flat thoracic). The upper part of the figure shows the mean tumour amplitude from the PET data and the mean breathing depth from the sensor data. The lower part shows the mean tumour position from the PET data and the breathing mode reconstructed from the sensor data. To visualise the offset of the different tumour movements between the different scenarios, for each patient the mean positions are normalised to the smallest mean position of each patient. The figure shows, that for the given scenarios different amplitudes and offsets of the tumour are observed, as well as a change in the sensor signals. The results show a flexibility of the tumour movement in its amplitude and absolute position, which depends on the actual breathing patterns of the patient.

Conclusion: The performed clinical trial indicates that the movement of the tumour depends on the actual breathing pattern. This shows that it is important for the prediction of the tumour position to take the information on the breathing pattern into account. The detection of the breathing parameters with the sensors give the possibility for further investigations of a correlation between tumour offset and amplitude with reconstructed breathing depth and mode, which could be further used for individual motion prediction.

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EP-1744

Evaluation of the clinical accuracy of the robotic respiratory tracking system

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Purpose or Objective: The purpose of this study was to evaluate the clinical accuracy of the Synchrony Respiratory Tracking System (SRTS) of the CyberKnife (CK).

Material and Methods: We analyzed 65 patients with lung lesion who had been treated with the SRTS from August 2012 to August 2015. Respiratory motion data were obtained from cine magnetic resonance (MR) images. MR scans were performed with a 1.5-Tesla whole-body clinical MR scanner, and the cine MR images of sagittal plane were obtained. We collected respiratory motion data of each patient from the cine MR images using in-house software. The dynamic motion phantom (DMP) was used to reproduce the motion of both the tumor and the surface of the patient's abdomen. We used a 20 mm diameter plastic ball as the target. A gold marker was placed at the center of the ball. Treatment plans were created based on static CT scans and standard CK treatment parameters. Each plans utilized ten beams with several different source positions. All of the beams in each plan were aimed at the center of the ball target, and were set to 200 MU for 15 seconds of data acquisition. The CK was subsequently operated with the SRTS, with a CCD camera mounted on the head of the linac. The central axis of the CCD camera was matched to the central axis of the linac beam using a custom-built jig. The recording by CCD camera was performed during the tracking of the ball target by the linac. The tracking error was defined as the distance from the center of the images to the center of the ball in the images recorded by CCD camera. The tracking error was measured at 30 Hz using in-house software. The probability in excess of 95% (Ep95) for each direction was estimated. The SRTS accuracy was defined as the median value of Ep95 for ten beams (Ep95med)

Results: The mean value and standard deviation of Ep95med was 2.5 ± 0.9mm. The Spearman's correlation coefficient determined by the rank test indicated that the range of motion of the tumor was significantly related to Ep95med (P<0.01).

Conclusion: The accuracy of SRTS was considered to be clinically acceptable. However, suitable margin to the clinical target according to the range of motion of the tumor seems to be necessary for the safe treatment to each patient.

EP-1745

Radiotherapy in breast cancer with voluntary deep-inspiration breath-hold using BrainLab Exactrac

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Purpose or Objective: Adjuvant radiotherapy in left-sided breast cancer with voluntary deep-inspiration breath-hold technique (vDIBH) may reduce the irradiation dose to the heart. The aim of this study is to estimate the heart, lung and PTV dosimetric constraints and the reproducibility of vDIBH radiotherapy using BrainLab Exactrac monitoring system.

Material and Methods: 10 women with left breast cancer who had undergone breast-conserving surgery and who required adjuvant radiotherapy to the whole breast, were enrolled and were shortly trained before simulation CT-scan to hold their breath. The first scan was acquired in free-breathing (FB_CT) and the second one in vDIBH (vDIBH_CT). Target and organ-at-risk (OAR) volumes were delineated in both CT scans and for both of them computerized treatment planning was performed using two tangential fields technique. We compared the dose distribution for the heart, left anterior descending coronary artery (LAD), ipsilateral lung and planning target volume (PTV) using standard defined parameters: mean dose and maximal dose applied to the LAD; percentage of the heart volume receiving at least 5 Gy (V5Gy) and 10 Gy (V10Gy); percentage of the ipsilateral lung volume receiving at least 20 Gy (V20Gy); and the volume of the PTV receiving 95% of the prescribed dose (V95%). The online monitoring during EPI acquisition and treatment were made by BrainLab Exactrac system. Daily real time electronic portal imaging (EPI), in CINE modality (captured during the beam delivery) were performed in order to check the reproducibility of the technique. Wilcoxon test has been used to compare dosimetric heart, lung and PTV parameters between FB_CT and vDIBH_CT treatment plans. The mean displacement, detected with the portal images, was calculated for each treatment beam and for each patient.

Results: A significant reduction in heart V5 and LAD Dmax (2.71 vs 0.99 Gy p=0.02 and 16.56 vs 6.90 Gy p= 0.012 respectively) parameters was recorded for vDIBH_CT treatment plans (see Table 1 for complete results). There were no significant differences between vDIBH and FB treatments in lung dosimetric parameters and target volume coverage. 1694 portal images were evaluated. During treatment, the mean displacements observed in the longitudinal, vertical and lateral direction were 0.132 mm (SD= 0.011), 0.013 mm (SD= 0.137), 0.116 mm (SD= 0.010).

Dosimetric Parameters		vDIBH	FB	p
Heart V5Gy	Mean ± SD	0,992 ± 1,6	2,708 ± 2,357	0,02
	Median	0,392	2,6	
Heart V10Gy	Mean ± SD	0,119 ± 0,267	0,427 ± 0,377	0,04
	Median	0,000	0,5	
LAD maximum dose	Mean ± SD	6,9 ± 4,198	13,562 ± 5,678	0,012
	Median	5,2	13,555	
LAD mean dose	Mean ± SD	3,1 ± 1,76	5,525 ± 1,993	0,012
	Median	2,850	5,5	
Lung V20Gy	Mean ± SD	5,79 ± 2,556	4,463 ± 2,866	0,441
	Median	6,410	4,720	
95% PTV	Mean ± SD	98,58 ± 1,002	98,224 ± 1,089	0,401
	Median	98,94	98,92	

vDIBH: voluntary deep inspiration breath hold

FB: free breathing

LAD: left artery descending

Conclusion: vDIBH technique reduces cardiac irradiation compared with conventional free-breathing treatment plans, without jeopardizing the proper coverage of the target. vDBIH for left-side whole breast irradiation can be accurately implemented using BrainLab Exactrac system with high and accurate reproducibility (mean shift < 0.15 mm).

EP-1746

Stereo/monoscopic motion tracking of the prostate using room-mounted x-ray image guidance

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Purpose or Objective: Intrafraction internal motion of the prostate currently limits the accuracy of external beam radiotherapy, requiring expanded ITV boundaries and introducing geometric uncertainty. Techniques to monitor prostate motion at the millimeter scale are thus needed. Room-mounted dual x-ray systems can provide stereoscopic localization of the prostate via implanted fiducial markers, however the treatment head frequently blocks one of the x-ray tubes as the gantry rotates. We implemented a monoscopic 3D localization algorithm, allowing localization even when one of the x-ray tubes is obstructed. We show that this technique allows accurate localization throughout the treatment fraction, improving the tracking capabilities of room-mounted x-ray systems.

Material and Methods: A gold fiducial marker was placed in the prostate of an anthropomorphic phantom, and initially aligned to isocentre. The linac couch was used as a translation stage, and programmed with a realistic prostate motion trajectory. Continuous dual x-ray images (140 kVp,