VYeo, ITVEI+EE(End of Inspiration + End of Expiration), ITVODD (delineated from five odd p-hases), ITVEVEN (delineated from five even phases), ITVAVG (Average sequences) , and IT-VMIP (Maximum Intensity Projection sequences) were calculated and evaluated, finally, a method , which was not sensitive to the tumor volume and motion characteristic was selected for clinical use.

Results: The mean tumor motion (RLR, RAP, RCC, and R3D) were 3.5mm(1.4mm~8.4mm)、4.5mm(1.1mm~8.6mm)、9.5mm(0mm~10mm),12.3mm (2.5-55.3 mm) respectively. Compared with ITV10, the volume of ITVx were underestimated by25.7%、35.6%、17.9%、12.8%、3.6%、4.8% (P=0.000) respectively. MI comparisons between six ITVx delineation methods and ITV10 had statistical significance: 0.69、0.62、0.80、0.86、0.93、0.91（P=0.006） EI showed no statistical significance: 0.98、0.98、0.97、0.97、0.99、0.98（P=0.13）, the tumor volume and motion amplitude were certified not the independent factors for the MI of ITVODD and ITVEVEN.

	Range	Mean±SD	Comparison	P value
RVI _ITVMIP	0.53-0.91	0.74±0.12	ITV10 - ITVMIP	0.00
RVI _ITVAVG	0.36-0.88	0.64±0.13	ITV10 - ITVAVG	0.00
RVI _ITVIE+EE	0.71-0.88	0.82±0.51	ITV10 - ITVIE+EE	0.00
RVI _ITVyeo	0.75-0.95	0.87±0.06	ITV10 - ITVyeo	0.00
RVI _ITVODD	0.88-0.98	0.97±0.02	ITV10 - ITVODD	0.53
RVI _ITVEVEN	0.83-0.96	0.95±0.04	ITV10 - ITVEVEN	0.17

Conclusion: ITVODD/EVEN was not sensitive to tumor size or motion characteristic and was proved to have a good marching with ITV10 meanwhile having a relative high contouring efficiency, it can be recommend as a universal ITV delineation method to the institutions which was not equipped with the deformable registration systems.Introduction

EP-1731

Changes of the prostate motion errors in the intra-fraction early phase for prostate cancer patients

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Purpose or Objective: In recent years, 3DCRT and IMRT have been used frequently as a treatment approach for prostate cancer patients. In particular, there is a tendency that a short-term treatment is performed with the use of a high dose rate machine. For this reason, even a small movement of the intra-fraction prostate motion error is also important. In this study, we divided one time of irradiation of 3DCRT and IMRT into 2 stages, i.e., the early phase and the late phase, and examined the intra-fraction prostate motion errors in a single irradiation.

Material and Methods: A total of 154 patients with prostate cancer were treated from January 2005 to December 2013. Three gold markers were inserted into their prostate gland before starting radiotherapy. Patients treated with 3DCRT (88 pts) were fixed at their lower limbs using HF-A (TOYO MEDIC) in the supine position, and those treated with IMRT (66 pts) were secured their whole body using MOLDCARE RI II (ALCARE). We measured the travel distance of the center of gravity of the three gold markers in the prostate gland using the real-time tumor tracking system. We defined the travel distance of the first half (the early phase) and latter half (the later phase) of the intra-fraction prostate motion errors right after the initiation of irradiation. In addition, we analyzed the differences caused by the fixation methods (fixture).

Results: A total of 9,750 times of irradiation (3DCRT : 4,732; IMRT : 5,018) were analyzed in this study. The overall duration of daily irradiation was 13.83±2.24 minutes. The travel distance of the prostate was 1.50±1.13 mm in the entire one time irradiation, 1.75±1.21 mm in the early phase, and 1.24±0.98 mm in the later phase. The statistical analysis using the Bonferroni method showed a significant difference between the both phases (p<0.001). The intra-fractional prostate motion errors in the early phase were 1.96±1.36 mm by 3DCRT and 1.55±1.01 mm by IMRT. A significant difference was observed in the intra-fractional prostate motion errors in the early phase between two fixation methods. In contrast, the intra-fraction prostate motion errors in the later phase were almost equal regardless of the fixation methods.

Conclusion: The temporal movement of the prostate during daily irradiation becomes larger in the early phase of irradiation, and this result is influenced by the set-up methods and the patient fixing devices. Since the dose gradient is steep in 3DCRT and IMRT, even a minimal movement of the prostate associated with the intra-fraction prostate motion errors is likely to cause a fatal irradiation error of a high dose rate machine. Therefore, the movement of the prostate in the early phase would require careful attention in the treatment of prostate cancer patients.

EP-1732

Quantitative estimation of gamma passing rates from characteristics of respiratory motion

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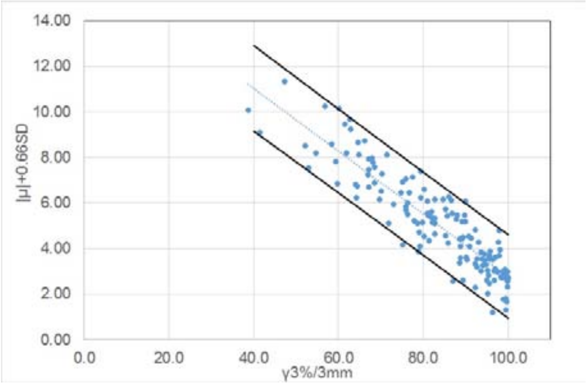
Purpose or Objective: The purpose of this study is to quantitatively estimate gamma (γ) passing rates from characteristics of respiratory motion.

Material and Methods: A VMAT plan for lung cancer patients, which was designed using Pinnacle3 (ver. 9.2; Philips Ltd, USA), was used. Measurements were performed on the Elekta Synergy (Elekta Oncology Systems Ltd, Crawley, UK), which has a 160-leaf independently moving MLC with 5-mm leaf width. Beam energy was set to 6 MV photon beam. The I'mRT Phantom (IBA Dosimetry GmbH, Schwarzenbruck, Germany) was set on a motor-driven base (QUASAR Programmable Respiratory Motion Platform; Modus Medical, London, ON, Canada). The motor-driven base moved in a direction parallel to the couch direction at angle of 0 deg. A total of 148 respiratory patterns was tested. The doses delivered to the Gafchromic EBT3 films (Kodak, Rochester, NY), inserted in the coronal plane of the I'mRT Phantom, were compared with under moving and static conditions without dose normalization. The irradiated films were scanned in the same orientation using a resolution of 72 dpi in the 16-bit red-channel color scale. Four pinholes were made on each film to identify the irradiated center. All of the films were analyzed using commercially available radiation dosimetry software (DD system, ver. 10.4; R'Tech Inc., Tokyo, Japan). The passing rates of the γ with the criterion of 3%/3 mm (γ3%/3mm) were calculated in the area receiving more than 30% of the isodose. In addition, mean respiratory position (μ) and its standard deviations (σ) were calculated from respiratory curves during beam irradiation.

Results: Absolute value of μ (|μ|) and σ ranged from 0.0 to 8.5 mm, and from 1.5 to 6.7 mm, respectively. Multi-regression analysis revealed that the impact of σ on the γ3%/3mm had 0.66-fold greater than that of |μ|. Means±SDs of the γ3%/3mm and the |μ|+0.66σ (|μ|+0.66σ) were 83.1±14.0% (range, 38.7-100.0%), and 8.7±3.1 mm (range, 4.6-14.2 mm), respectively. A strong correlation between the γ3%/3mm and |μ|+0.66σ was observed (R=-0.90).



Conclusion: We have demonstrated that the γ3%/3mm can be quantitatively estimated from the characteristics of respiratory motion. From the results of multi-regression analysis, reducing the amplitude of respiratory motion would provide high γ3%/3mm.

EP-1733
Deep inspiration breath-hold technique using an Arduino

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Purpose or Objective: A large effort has been made in recent years to develop techniques to reduce the dose to normal tissue (especially heart dose) for patients receiving radiation treatment for breast cancer. The deep inspiration breath-hold technique (DIBH) can decrease radiation dose delivered to the heart and this may facilitate the treatment to the internal mammary chain nodes. The aim of this work was both to develop a DIBH method using an Arduino Uno microcontroller board (SmartProyects, Ivrea, Italia) and a simple software to visualize the patient's level of inspiration. This method provides a cheaper solution to the more expensive commercial ones.

Material and Methods: Arduino is an open-source electronics platform based on an easy-to-use hardware and software. We plugged a tri-axial low-g digital acceleration sensor (Bosch's *BMA180)* to our Arduino board. This accelerometer is then placed on the patient and used as a surrogate to measure the expansion of the patient's thorax during breathing. Even though we chose the gravitational 1g range and our BMA 180 provides a digital full 14 bit output signal, this is still not enough to accurately measure the acceleration changes produced in the patient's thorax during her breath cycle. We thus measure the orientation change in our BMA180 inside the gravitational field. However, this orientation change is good enough to accurately measure the changes in the patient's breath cycle. With an In-house developed software programmed in Python 2.7 we are able to visualize these measures and, accordingly, the patient's breathe cycle.

Results: We were able to build a DIBH system using both an Arduino board and an accelerometer. We visualize the patient's breathe cycle with an In-house software and establish a threshold based on its amplitude. We provide patients with a real-time breathe cycle visualization, so they can have a visual feedback mechanism in order to properly hold their breath when required.

Conclusion: Several DIBH methods are commercially available. These methods can decrease the radiation dose delivered to the heart. We have developed an In-house DIBH system with all the functionalities required to implement this technique in our clinic. Building this system is really cheap and amounts to nearly 60 Euros. We are more than happy to freely provide the software needed to implement this method.

EP-1734
IGRT for prostate cancer: intrafraction variation analysis and CTV-PTV margin determination

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Purpose or Objective:
1.to evaluate first set-up accuracy and corrections needed before treatment administration
2.to assess intrafraction variability
3.to determine CTV-PTV margins according to intrafraction uncertainties

Material and Methods: Forty-five consecutive prostate cancer patients, undergoing radical or postoperative image-guided radiation therapy with or without gold seed implant in a newly opened department, were considered. On each session a first set of portal images was obtained at 0° and 90° degrees, using a low-dose MV imager. Positioning errors were measured in the three directions and corrected if > 1 mm. After treatment a second set of images was daily produced and displacements measured. Comparison between before-treatment images and planning DRRs represents set-up accuracy. Comparison between end-of-treatment images and planning DRRs shows intrafraction variability Systematic and random errors were analysed and incorporated in the Van Herk formula (2.5 Σ+ 0.7 σ), to determine ideal CTV-PTV margins.

Results: All patiens were suitable for the analysis. Results are summarized in the table.

	AXIS	MEAN (mm)	Σ (mm)	σ (mm)	CTV/PTV margin
FIRST SET-UP	R-L (left:+)	-0.3	1.7	3.1	6.3
	A-P (anterior:+)	-0.8	2.3	3.7	8.4
	C-C (caudal:+)	+0.2	2.0	3.2	7.2
INTRA-FRACTION	AXIS	MEAN (mm)	Σ (mm)	σ (mm)	CTV/PTV margin
	R-L(left:+)	+0.2	0.5	1.2	2.2
	A-P (anterior:+)	-0.3	0.7	1.4	2.7
	C-C (caudal:+)	+0.1	0.4	1.1	1.7
Σ = systematic error σ = random error					

A total of 6632 images were analysed. Mean errors were <1 mm for all measurements. In intrafraction shift analysis systematic errors were <1 mm, random errors were <2 mm and calculated CTV-PTV margins ranged from 1.7 to 2.7 mm.

Conclusion: Good accuracy and precision for first positioning procedures were found. If hypothetically IGRT were omitted and CTV-PTV margins were based on first set-up errors only, margins ranging from 6.3 to 8.4 mm in the various directions would be mandatory. On the contrary, according to the policy of our department, with the use of daily IGRT and based on our excellent results of intrafraction variation analysis, CTV-PTV margins can be limited to 2.2, 2.7 and 1.7 mm, respectively in lateral, anteroposterior and craniocaudal direction.

EP-1735
Impact of respiratory motion on breast tangential radiotherapy using the field-in-field technique

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Purpose or Objective: The field-in-field (FIF) technique has become a widely performed method of administering tangential whole breast radiotherapy. However, as the FIF technique requires the precise setting of the position of the multi-leaf collimators (MLCs) in order to reduce hot spots, there is concern that its use could significantly change the dose distribution to the target volume due to respiratory