evaluate the dose volume histograms (DVH) of rectum and bladder in high dose proton therapy for prostate cancer.

Material and methods: Thirty patients with localized prostate cancer treated by combination of photon/proton therapy (Tx1) were included in this study. *Tx1* consisted of 50 Gy/25 fx photon beam to the prostate and bilateral seminal vesicles (P/SV) by conformal technique of 240 degree-arc followed by proton boost of 26 GyE/13 fx to the prostate (P). For the same patients, we made three different plans of proton therapy as follows; *Tx2*: 50 GyE/25 fx to P/SV followed by 26 GyE/13 fx boost to P, *Tx3*: 76 GyE/38 fx to P/SV, *Tx4*: 76 GyE/38 fx to P. All proton beams were planned in lateral opposed fields. The rectum including filling was contoured from sigmoid flexure to anal verge. The DVHs of rectum and bladder were respectively compared between 4 treatment plans.

Results: V40 (%volume that receives $\geq$ 40 Gy) - V75 of rectum and bladder in 4 treatment plans are shown in Table 1. Percent volumes of three proton plans (Tx2-4) were lower than those of the photon/proton plan (Tx1) in both rectum and bladder, over all dose levels. The DVHs of the plan to deliver full dose to P/SV (Tx3) were similar to those of the other proton plans.

Table 1. % Volume

		V40	V45	V50	V55	V60	V65	V70	V75
Rectum	Tx1	68.3	63.8	60.4	55.1	48.9	43.7	19.4	2.3
	Tx2	33.6	29.5	26.8	22.4	17.7	14.2	8.4	3.5
	Tx3	35.6	31.0	28.3	23.5	18.5	14.6	8.5	3.4
	Tx4	29.9	26.6	23.9	20.2	16.2	13.3	8.1	3.5
Bladder	Tx1	80.4	76.5	73.9	69.9	65.4	62.1	56.5	46.3
	Tx2	56.1	52.8	50.6	47.2	42.6	38.8	32.6	23.6
	Tx3	55.8	52.7	50.4	46.8	42.2	38.8	32.3	23.7
	Tx4	56.8	53.1	51.1	48.0	43.2	38.9	33.1	23.3

Conclusions: Percent volumes of rectum and bladder were reduced in the proton treatment plans, compared with the photon/proton plan. It is suggested that dose escalation for prostate cancer is feasible by proton therapy.

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Verification of Fluence Map (FM) in dynamic radiotherapy techniques

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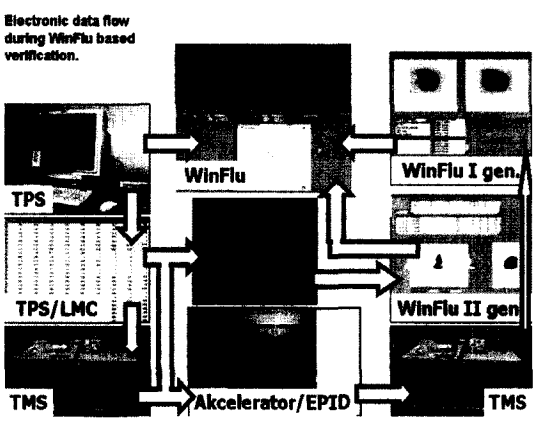
Background: Comparing to conformal radiotherapy, the Quality Assurance (QA) program for dynamic techniques (Intensity Modulated Radiation Therapy IMRT, Intensity Modulated Radiation Surgery - IMRS) requires some additional procedures. The purpose of the paper is to develop the method for FM assessment obtained from planning, data management and treatment. Presented method is based on WinFlu software originally developed in Treatment Planning Unit in Center of Oncology Institute in Gliwice, Poland.

Material and methods: First FM is imported from Leaf Motion Calculator (LMC) in TPS (CadPlan or BrainSCAN). Second one is obtained from TMS. The WinFlu generates FM to get digital image from static MLC segment positions there. Several images are imported from EPID, then blended by WinFlu generator to obtain third FM. Subsequently images are modified using the gray scale gradient and resolution for comparable conditions. The WinFlu verify three obtained FM by their profiles and gray scale intensity to find out differences. Results are stored to database for future checks and documentation.



Results: The verification method of Fluence Map enables to check dynamic MLC or mMLC plans for any inaccuracy among planning, data management and treatment (LMC/TPS, TMS, EPID).

Conclusions: Verification of the FM based on WinFlu software might constitute a useful method in QA improvement.

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A four dimensional simulation model of the response of solid tumours to radiotherapy in vivo: advances and validation.

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Current radiotherapy (RT) treatment planning (TP) is based on physical optimisation of the dose distribution and on rather crude biological models of tumour and normal tissue response. The introduction of advanced biosimulation methods is expected to substantially improve the RT efficiency. To this end a 4-D patient specific simulation model of the response of malignant tumours to RT schemes *in vivo* has been developed [1,2]. Substantial improvements are presented in this paper.

The Model The imaging data of the patient (e.g. MRI, PET), as well as his/her histopathologic, genetic (e.g. p53 status) and historical data are appropriately collected and introduced into the simulation software. The 4-D simulation procedure is based on the cell cycle, the oxygen and nutrient supply, the LQ model of cell response to RT and the mechanical properties of tissues. The model predictions are visualized using virtual reality techniques (Fig. 1).

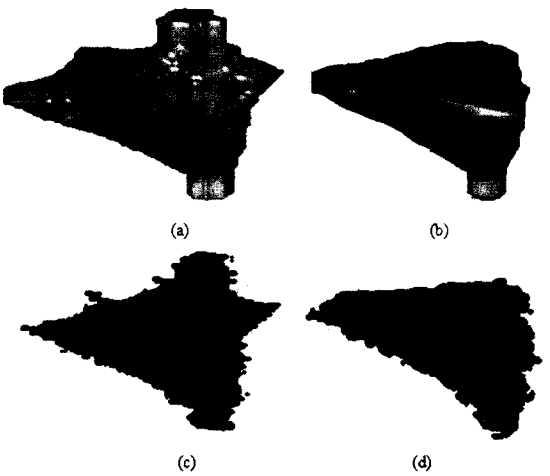

Fig 1. A 3-D visualisation of a glioblastoma multiforme tumour *in vivo*. (a) and (b): external boundary and internal structure of the tumour before RT (c) and (d): 20 days after the beginning of RT (standard fractionation scheme: 2 Gy/day, 5 d/wk, 60 Gy total). Color code: grey: "prolif. layer", dark grey: "dormant layer", black: necrotic layer. A special colouring criterion has been applied.

Improvements A new algorithm leading to conformal shrinkage of the tumour as a response to RT has been developed. Different values for the LQ parameters for each cell cycle phase and the G phase can be introduced based on the experimentally estimated oxygen enhancement ratio. Extensive use of random number generators has been made in order to better simulate the distribution of tumour cells within each given cell cycle phase. Finally, an alternative algorithm accounting for an approximately constant vascularisation field has been developed.

Results The model has been applied to the glioblastoma multiforme case. Various fractionation schemes have been simulated and qualitative agreement with clinical experience has been ensured. A preliminary clinical adaptation and testing process is in progress in the Metaxa Cancer Hospital. Large scale clinical tests have been planned to take place after completion of the preliminary testing stage.

Conclusion Qualitative agreement of the improved model with the clinical experience is followed by clinical tests. The final software is to be used as a decision support and biological TP system by performing *in silico* experiments.

References

[1] G.Stamatakos, D.Dionysiou, et al. *In vivo* tumor growth and response to RT& " Int. J. Radiat Oncol Biol Phys vol. 51 (3), Sup. 1: 240, 2001.