STEREOTACTIC BODY RADIATION THERAPY

Implementazione, Sostenibilità, Avanzamento Tecnologico e Risultati a Confronto

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EPID Dosimetry: a useful tool for PreTreament patient-based Quality Assurance?

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INTRODUCTION

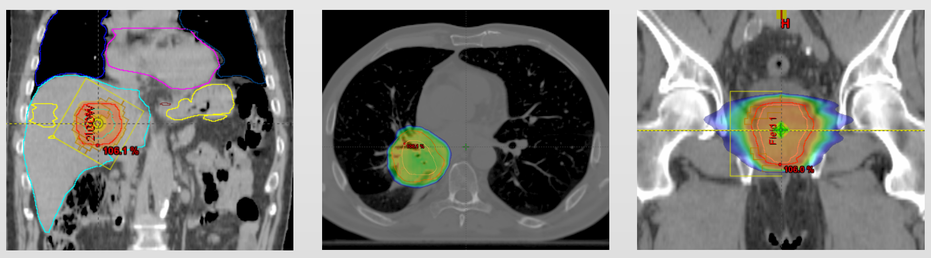
Stereotactic Body Radiation Therapy (SBRT) has evolved from a technology used only in specialized centers to a widely spread method.
A fast delivery using RapidArc (Varian Medical System) is particularly attractive for SBRT treatment which features precise delivery on high radiation dose in only few fractions. With the introduction of the RapidArc approach, it became essential to optimize the treatment planning process, and to evaluate plan quality, delivery accuracy and the calculated dose distributions.

PURPOSE

This study analyzes the possibility to use EPID (Electronic Portal Imaging Device) based dosimetry for Pre-Treatment patient-based Quality Assurance in SBRT planning (lung, liver and prostate case).
The purpose is to investigate the feasibility of using clinical parameters to assess delivery accuracy SBRT plans and the calculated dose distributions using a commercial software that calculates 3D dose from imported fluence acquired by EPID and a back-projection algorithm. Plan evaluation is performed in 3D.

MATERIALS AND METHODS

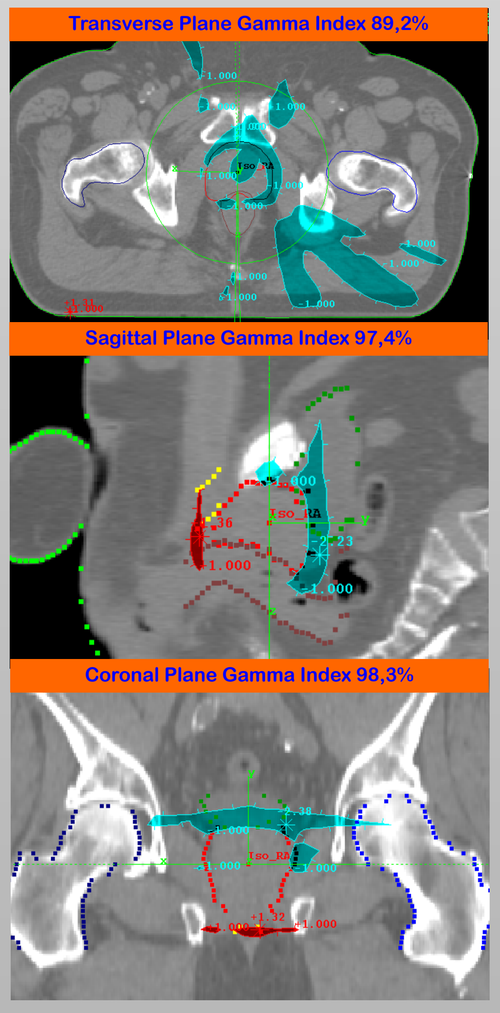
Varian Eclipse Treatment Planning System is used to planning VMAT treatments in different treatment sites (lung, liver, prostate). Verification plans are delivered using a Varian Clinac 2100CD linear accelerator's 6 MV photons beam. EPID images are acquired in cine-mode by a Varian aS1000. Calculations from fluence information are performed using Dosimetry Check (DC) software (Math Resolutions LLC).
Gamma Analysis in 3D is performed using global 3%/1mm gamma criterion. Dose distributions, point doses, gamma distributions and DVH statistics are compared.
Median (D50), minimum (D95) and maximum (D05) PTV doses and others relevant parameters are analyzed in terms of comparison between planned and measured doses. OAR values used during planning are reported.



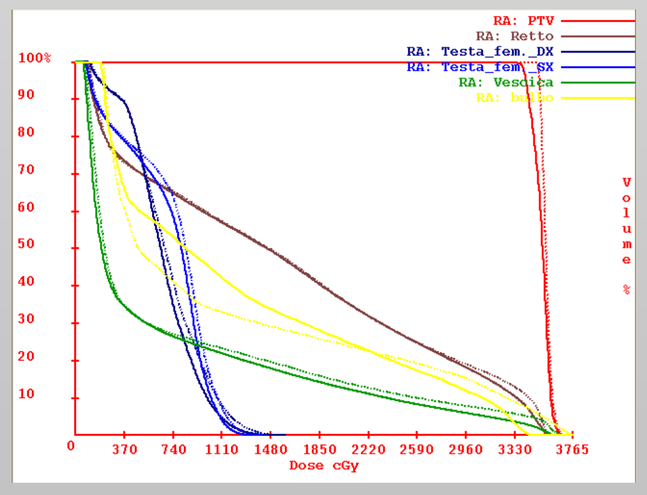
RESULTS

Results are reported for a prostate case (dose prescription: 35 Gy / 5 fractions). Γ analysis is performed in 3D for each CT patient slice and in the transverse, sagittal and coronal planes through the isocenter of the VMAT plan.
Red/cyan shows hot/cold γ failure areas.

3D Γ EVALUATION (3%1mm)



FROM Γ PASSING RATES TO DVH-BASED QA METRICS



PTV (red), rectum (brown), femoral heads (blue), bladder (yellow) and penis bulb (green) are shown.
Continous lines show TPS DVH;
Dot lines show DC DVH.
PTV and OAR's DVH measured by DC are used to clinically quantify the performance of the plan through dose constraints used during plan optimization. Differences between TPS and DC are within 3% on average.

Structure	Dosimetric Parameter	Planning Value	Measured Value	Difference (%)
PTV	D_{mean}	35,0 Gy	35,3 Gy	-1,0%
	$D_{98\%}$	35,1 Gy	33,9 Gy	-3,3%
	$D_{95\%}$	35,2 Gy	34,1 Gy	-3,1%
	$D_{93\%}$	35,2 Gy	34,2 Gy	-2,8%
	$D_{90\%}$	35,2 Gy	34,4 Gy	-2,3%
	$D_{2\%}$	36,6 Gy	36,4 Gy	-0,5%
	$D_{0,1\%}$	36,9 Gy	36,8 Gy	-0,3%
Rectum	$D_{0,1\%}$	35,9 Gy	35,7 Gy	-0,6%
	D_{mean}	15,7 Gy	15,5 Gy	-1,0%
	V_{33Gy}	13,3%	10,9%	-2,4%
	V_{28Gy}	21,0%	20,6%	-0,4%
	V_{18Gy}	41,8%	41,2%	-0,6%
Bladder	$D_{0,1\%}$	36,8 Gy	36,1 Gy	-1,9%
	D_{mean}	7,5 Gy	6,9 Gy	-0,8%
	V_{30Gy}	7,6%	5,8%	-1,8%
	V_{18Gy}	16,5%	14,8%	-1,7%
Penis Bulb	$D_{0,1\%}$	37,5 Gy	34,5 Gy	-1,9%
	D_{mean}	11,5 Gy	12,3 Gy	+1,1%
Femoral Heads	$D_{0,1\%}$	13,4 Gy	12,9 Gy	-3,8%
	D_{mean}	7,1 Gy	6,7 Gy	-1,0%

CONCLUSIONS

EPID dosimetry is an interesting tool in SBRT planning: quick experimental setup demands minimal time machine and a lot of clinical data are avaible to guarantee both accuracy and flowing delivery of a SBRT plan. DVH comparison is an unusual and instant tool to assess clinically plan's quality performance. Pass/fail decisions can be based on the difference between the planned patient dose and DVH. Dosimetry results can be reported in terms of clinical relevant parameters. More research is needed to assess optimal values for alert criteria.

REFERENCES: (1) Wu et al. *3D gamma QA for IMRT and VMAT,* Med. Phys. 39 (6), June 2012
(2) Low et al. *IMRT dosimetry tools,* Med. Phys. 38 (3), March 2011