FFF VMAT SBRT of prostate cancer: impact on target dose coverage and rectal dose sparing from a slightly increased near maximum target dose, and from SpaceOAR® hydrogel insertion.

Ospedale Sacro Cuore - Don Calabria

R. Ruggieri[1], S. Naccarato[1], Fersino S,[1] Mancosu P,[2] Tomatis S,[2] Scorsetti M,[2] F. Alongi[1]

[1] *UO Radioterapia Oncologica, Ospedale 'Sacro Cuore – don Calabria', Negrar (VR), Italy.*

[2] *UO Radioterapia e Radiochirurgia, IRCCS Istituto Clinico Humanitas, Rozzano (MI), Italy.*

Introduction :

$D_p = D_{iso.}$
$95\%D_p \le D \le 107\%D_p$ — *ICRU 62* [1] → *ICRU 83* [2] → $D_p \approx D_{50\%}$; $D_{2\%} \le 107\%D_p$; $D_{98\%} \ge 95\%D_p$

7 Gy x 5fr. (RapidArc, ®Varian): NOT achievable goal

if we constraint : D_{1cc} (rectum, bladder, urethral-PRV) ≤ 35 Gy [3]

without endo-rectal ballon [4]

$D_{98\%} \ge 95\%D_p$ ⟶ $D_{95\%} \ge 95\%Dp$

Purpose :

Hyp. 1 [5]: $D_{2\%} \le 107\%D_p$ → $D_{2\%} \le 115\%D_p$?

Hyp. 2 [6-7]: ***SpaceOAR® hydrogel*** transperineal insertion ?

$D_{98\%} \ge 95\%D_p$ ~ $PTV_{33.2Gy} \ge 98\%$

Improved rectal sparing ?

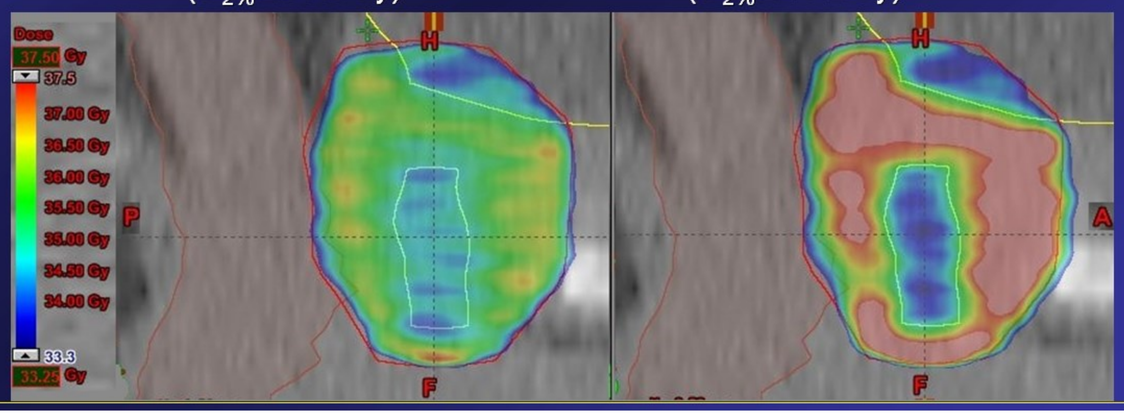
Methods / Materials :

11 patients: VMAT (RapidArc ®) plans, 10MV-FFF (TrueBeam)

2 CT-scans/pt.: {with spacer (***Spc***); without spacer (***NoSpc***)}

2 plans/CT: both assuring { $PTV_{33.2Gy} \ge 95\%$; D_{1cc} (rectum, bladder, urethral-PRV) <35Gy }

Hom-plans ($D_{2\%} \le 37.5Gy$) — ***Het***-plans ($D_{2\%} \le 40.2Gy$)

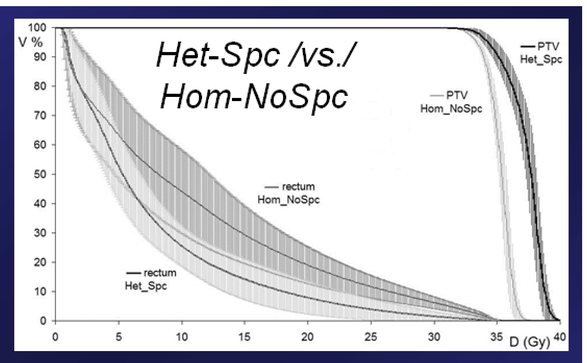


Results I:

Comparison of median/mean values for:

target dose coverage ($D_{98\%}$, $D_{50\%}$, $PTV_{33.2Gy}$, PTV_{35Gy}),

rectal dose sparing (V_{18Gy}, V_{28Gy}, V_{32Gy}).



p	$D_{98\%}$	$D_{50\%}$	$PTV_{33.2}$	PTV_{35}	V_{32} (%)	V_{28} (%)	V_{18} (%)
Hom-Spc /vs./ Hom-NoSpc	0.003	0.11	*0.005*	0.06	*0.0006*	5×10^{-5}	0.0003
Het-Spc /vs./ Het-NoSpc	0.009	0.027	0.012	0.002	*0.0002*	10^{-5}	0.0001
Het-NoSpc /vs./ Hom-NoSpc	0.067	$< 10^{-6}$	*0.016*	4×10^{-5}	*0.669*	0.349	0.273
Het-Spc /vs./ Hom-Spc	0.016	$< 10^{-6}$	0.015	0.0002	*0.973*	0.458	0.499
Het-Spc /vs./ Hom-NoSpc	0.0004	$< 10^{-6}$	*0.001*	2×10^{-6}	*0.0002*	2×10^{-5}	0.0002

I. Spacer ⇒ rectal sparing

Results II:

Linear correlation and ANOVA analyses between the variations resulting from spacer insertion in the fractional overlaps with PTV of rectum (ΔV^r_{ovl}) alone, or of the sum of rectum, bladder, and urethral-PRV (ΔV_{ovl}), and the corresponding variations in $PTV_{33.2Gy}$, and rectal V_X:

Hom-Spc /vs./ Hom-NoSpc r-values

	$\Delta PTV_{33.2Gy}$	ΔV^r_{32Gy}	ΔV^r_{28Gy}	ΔV^r_{18Gy}
ΔV^r_{ovl}	0.342	0.750 (.01)	0.628 (.05)	0.519
ΔV_{ovl}	0.767 (.009)	0.236	0.314	0.314

ANOVA

ΔV^r_{ovl}	$\Delta PTV_{33.2Gy}$	ΔV^r_{32Gy}	ΔV^r_{28Gy}
	0.974	0.009	0.03

Spacer insertion is not causative in improving target dose coverage.

Spacer insertion confirms to be causative in improving rectal dose sparing.

II. ($D_{2\%} \le 115\%\ D_p$) ⇒ improved Target dose coverage

Conclusions:

1. $D_{2\%}$ ≤40.2Gy (from 37.5Gy) was associated with an improvement in median/mean values for target dose coverage related metrics (e.g., $PTV_{33.2Gy}$), but not for rectal dose sparing ones.

2. Rectal spacer was associated with an improvement in median/mean values for both target dose coverage related metrics (e.g., $PTV_{33.2Gy}$), and rectal dose sparing ones (V_{28Gy}, V_{32Gy}).
   However, from correlation and ANOVA analyses, spacer insertion was not identified as a causal source for the observed improvement in target dose coverage.

3. The combined use of both spacer insertion and modestly increased accepted $D_{2\%}$ (≤40.2Gy) was finally associated with an improvement both in rectal dose sparing and in mean $PTV_{33.2Gy}$ value, which increased from 96.1% (±1.1%) to 98.7% (±1.2%).