From better technology to better clinical outcome:

Clinical implementation of SRS/SBRT/SABR with RapidArc and FFF beams (on TrueBeam)

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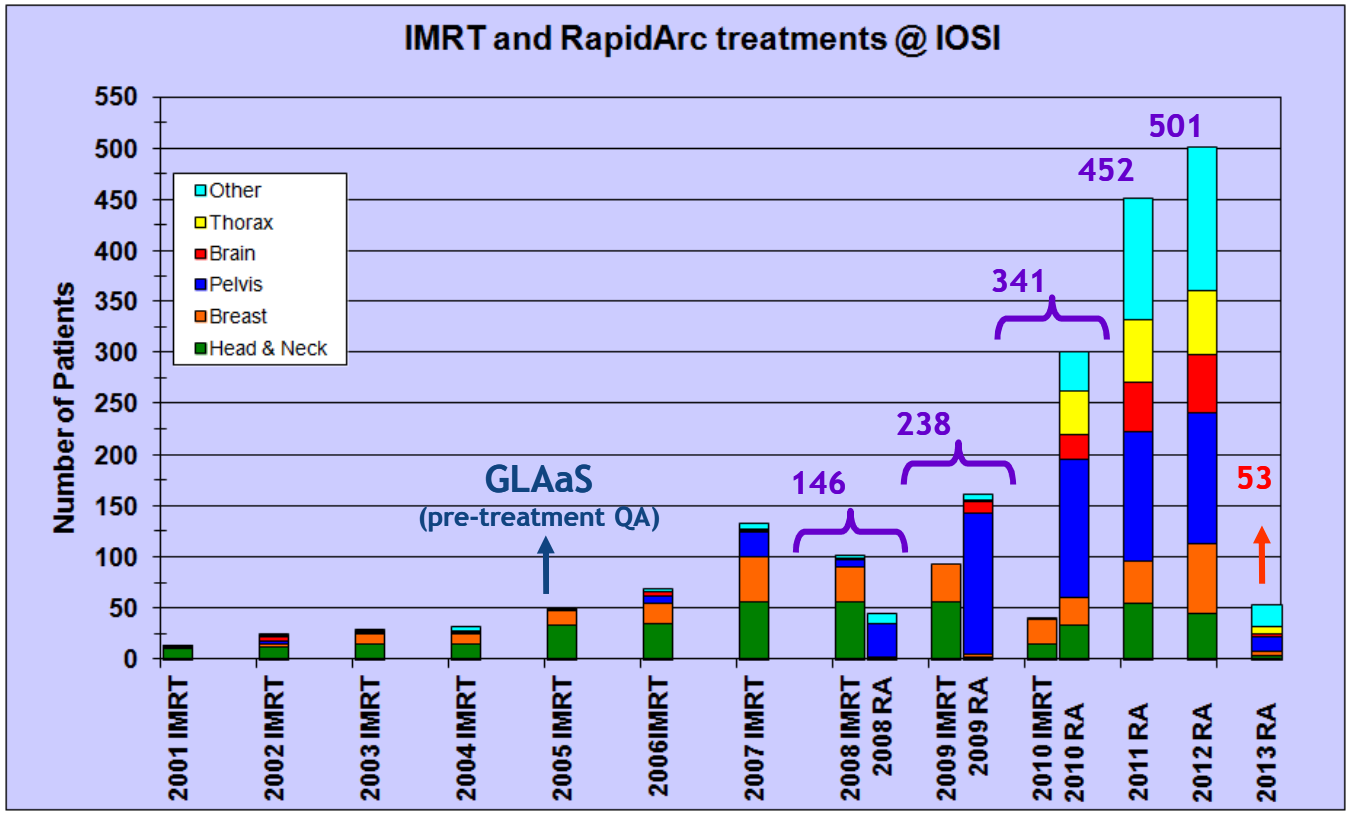
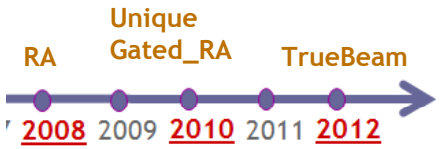
The power of RapidArc: IOSI

*First **RapidArc** treatment @ IOSI: Sept 8th, 2008*

*As per today: **1474 RapidArc** patients treated at IOSI (1860 plans)*



Migration of *the IMRT programme to RapidArc in 2010*



Statistics for

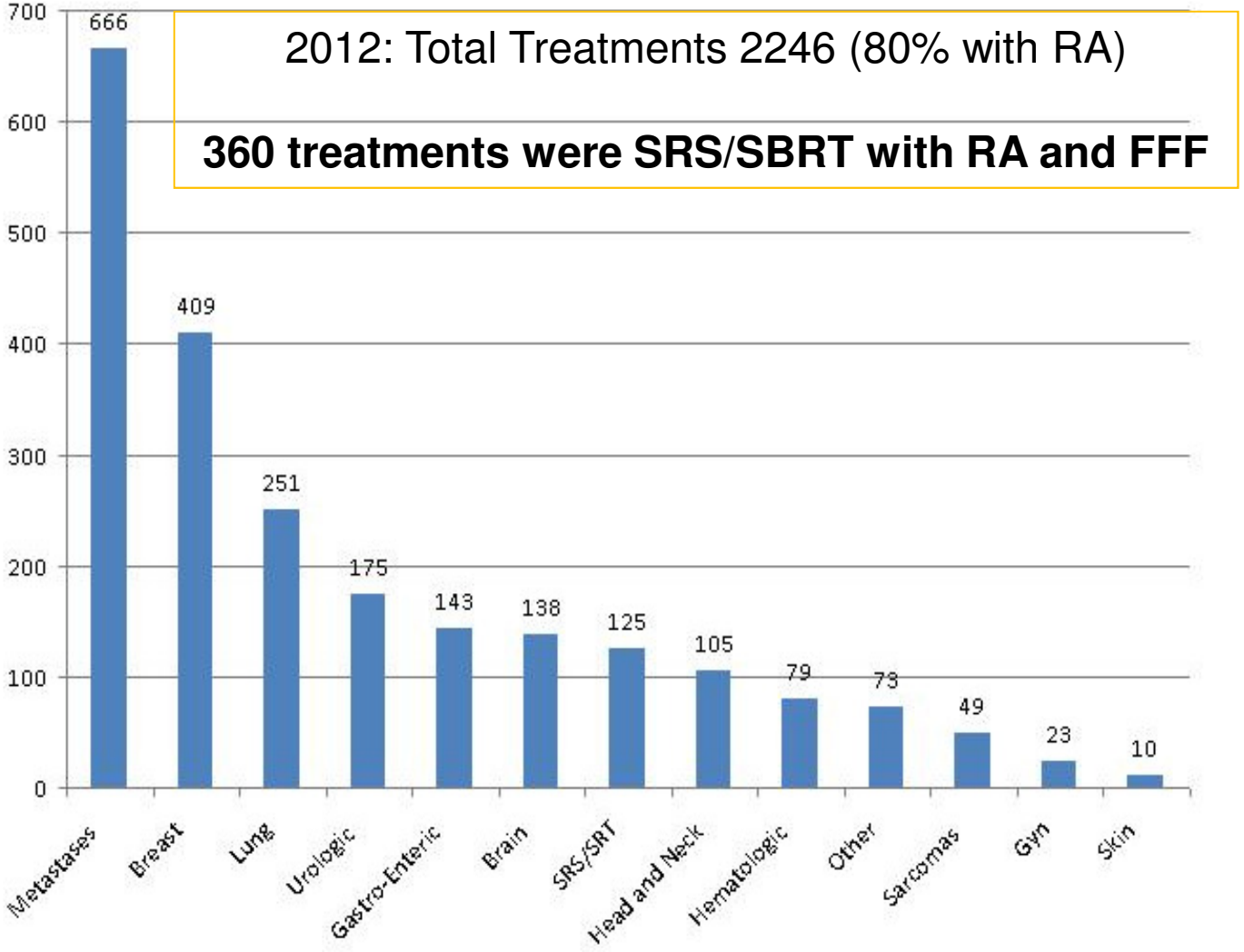
2009 -2010-2011-2012:

 # pat RA/total = 25% - 50% -79% -77%

Statistics for 2013

 # pat RA/total = 78.5%

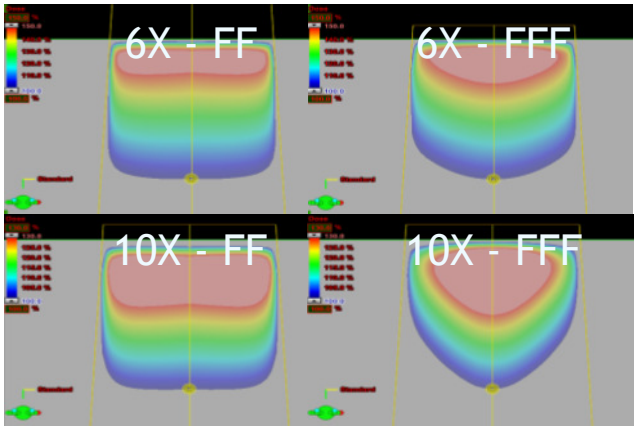
The power of RapidArc: Humanitas



What TrueBeam brought into the clinics

- **New beam delivery: high intensity mode or FFF mode**
- Advanced VMAT-RapidArc capability
- New imaging modalities (e.g. imaging during delivery)
- New technology and control systems: improved accuracy
- Ready for motion management and tracking
- Upcoming further technology (e.g. 6DoF couch)

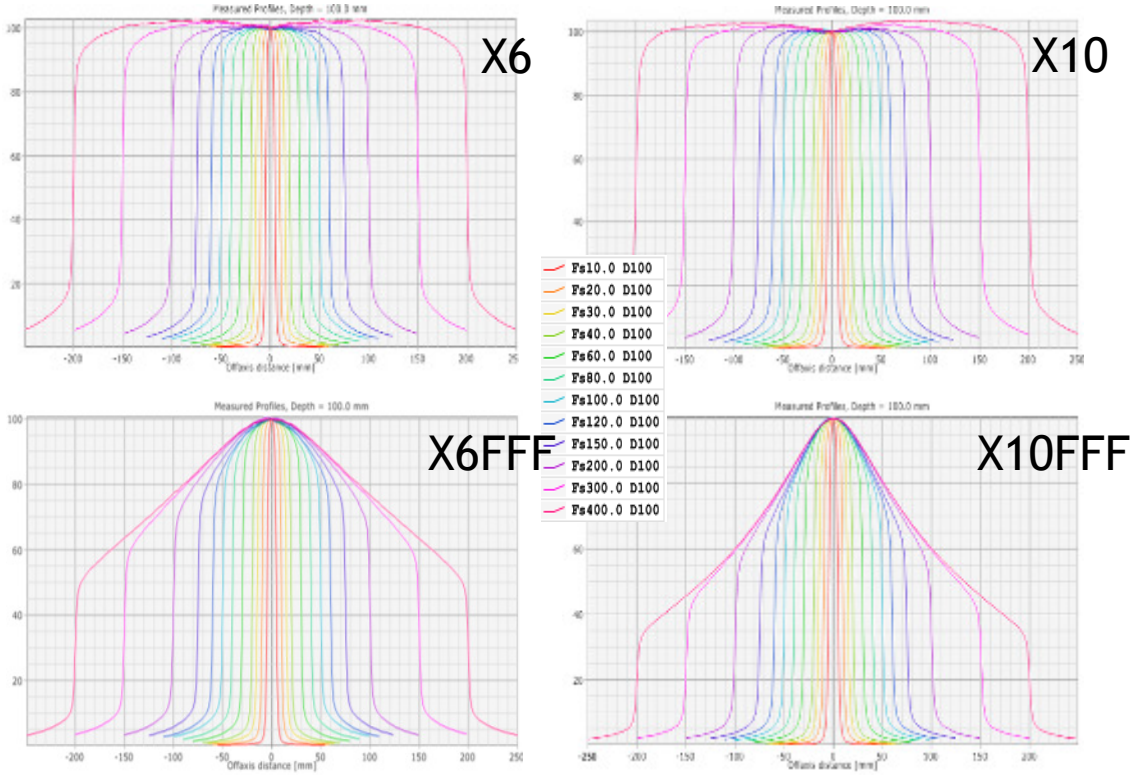
TrueBeam: FFF versus FF: Profiles



Non-flatness increases with energy
Up to 3x3 cm^2, difference in the profile for flattened and FFF is neglectable

Sharper penumbra in shallow depths for lower energies (shorter reach of secondary electrons)

Faster diverging penumbra with depth for lower energies (more likelihood of lateral scattering)



Why FFF ?

- unflattened beams ***can*** be used for IMRT and SBRT
- ***increased dose rate*** – reduction of delivery time *Fu et al, PMB (2004)*
- SBRT – high fractional doses (DIBH, gating)

- reduced scatter, leaf transmission and radiation head leakage *Kragl et al, R&O (2009)*
- reduced variation of beam quality across the beam *Georg et al, MP (2010)*
- ***reduced peripheral exposure*** *Kry et al, PMB (2010)*
- compared to conventional RT, IMRT has been found to increase PD *Kry et al, PMB (2010)*

TRUE BEAM initial clinical experience with FFF beam

70 FFF treatments analyzed

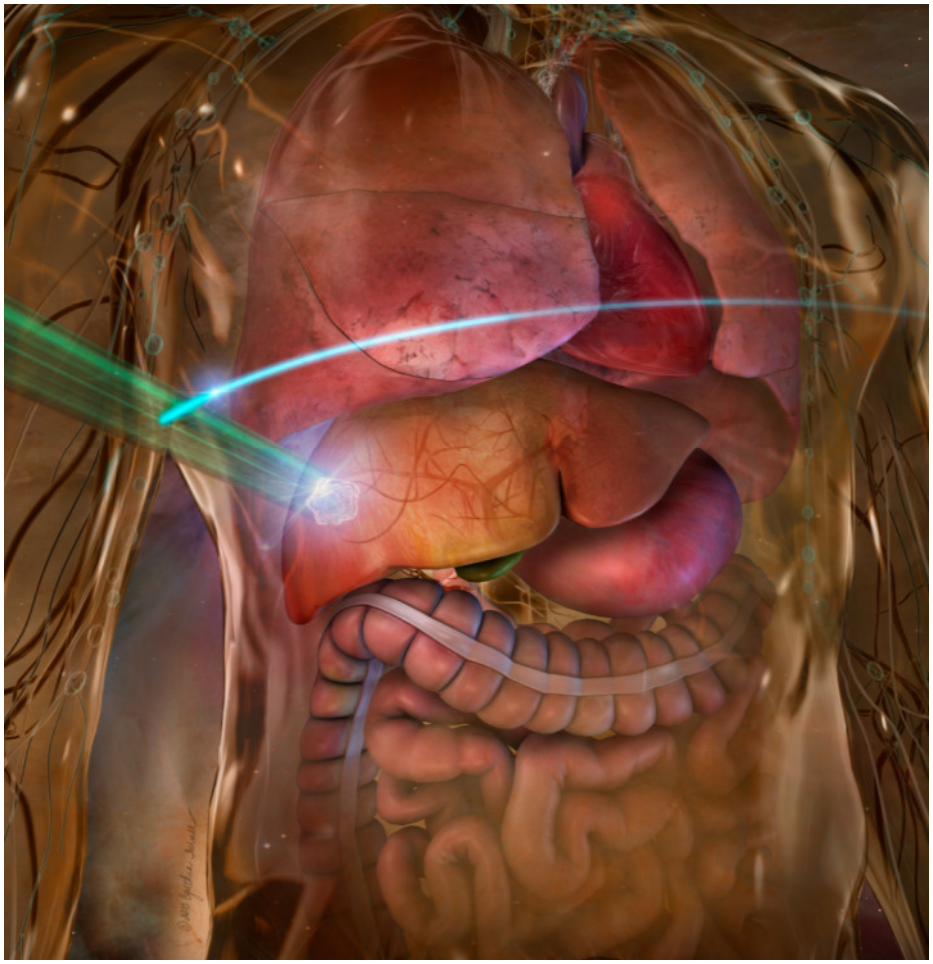
52 SBRT for lung lesions:
•Doses: 48 Gy in 4 fract.
•Toxicity:2 case of G2 and 3 G3 esophagitis

12 SBRT liver lesions:
•Doses: 75 Gy in 3 fract.
•Toxicity:2 case of G2 nausea/vomit

6 SBRT for abdominal nodes:
•Doses: 45 Gy in 6 fract.
•Toxicity: none

In 55/70 pts, early clinical outcome was assessable (very shor FU):
•10 complete response,
•26 partial response,
•13 stable disease.
•6 local progression.
90% of Local Control achieved in irradiated lesions

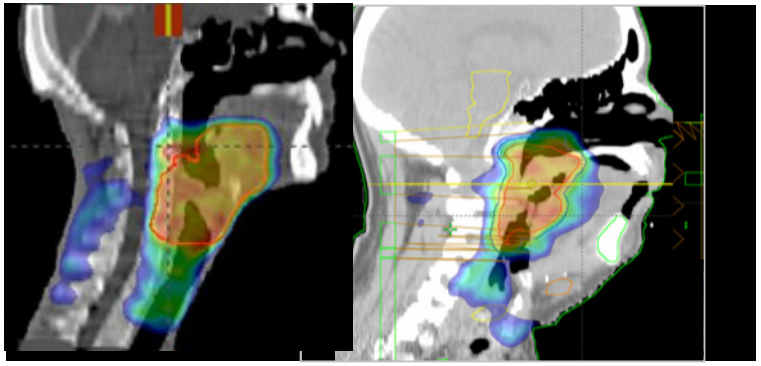
RapidArc (on TB) clinical results



- Head and Neck
- Lung
- Prostate
- Liver
- Pancreas

Focus on SRS and SABR

Does RapidArc have a role in Head and Neck?



2009 Vanetti E et al oro pharynx, hypo pharynx and larynx. Radiother. Oncol.

2009 Verbakel W et al. head and neck cancer. Int. J. Radiat. Oncol. Biol. Phys.

2010 Doonaert P et al locally advanced head and neck cancer. Int. J. Radiat. Oncol. Biol. Phys.

2010 Scorsetti M et al. Early clinical experience in head and neck cancer patients. Radiat. Oncol.

2010 Jacob V et al head an neck tumors. Strahl. Onkol.

2011 Doonaert et al. Subm. Gland sparing with RA. Radiat. Oncol.

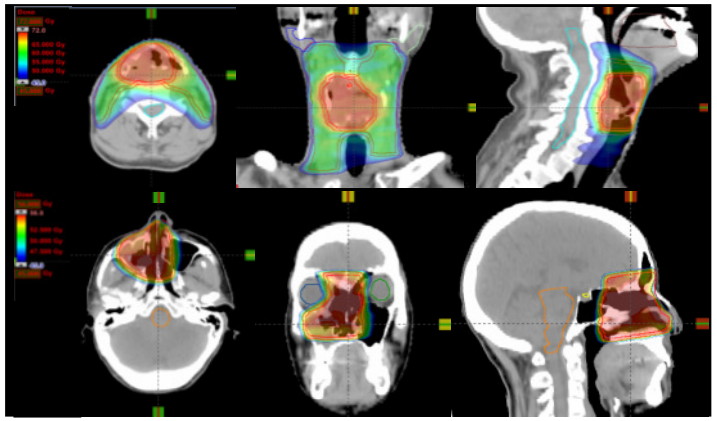
2011 Wiezorek et al. RA, IMRT and tomotherapy. A comparison. Radiat. Oncol.

2011 wiehle et al. RA vs IMRT in HN a comparison. Strahl. Onkol.

2012 Kahn et al. RA and IMRT with Acuros. IJROBP

2012 Alongi et al. Phase II trial: SIB with RA + cetuximab Strahl. Onkol.

Head and Neck:
Clinical results at Humanitas Institute



To date: >300 patients treated

Standard prescription:

Radical: 33 fractions, 69.96 Gy on T&N+ , 54.45 Gy on prophilactic nodes

Adjuvant: 30 fractions, 66 Gy on T&N

Site	Oral Cavity	7
	Nasopharynx	3
	Oropharynx	16
	Hypopharynx	1
	Larynx	10
	Paranasal Sinuses	6
	Other	2
Dose Prescription	Group A: 69.96/54.45Gy	

Toxicity report on first 45 patients:

		All	No ch	CDDP	Cetuximab
Completion of RT	Completed	43	10	16	17
	Interrupted	2	0	0	2
Mucositis	G0	1	0	1	0
	G1	15	3	7	5
	G2	8	1	4	3
	G3	12	1	2	9
Dermatitis	G0	1	1	0	0
	G1	18	3	11	4
	G2	11	1	3	7
	G3	6	0	0	6

Scorsetti et al. Radiat. Oncol. 2010

Head and Neck: RA in elderly

Prospective phase II trial of cetuximab plus VMAT-SIB in locally advanced head and neck squamous cell carcinoma

Tab. 2 Description of the population of study with patients stratified for T and N stage

Number of patients, *n* Percent of patients, %			Clinical T stage		Total
			T3	T4	
Clinical N stage					
NX		*n*	1	0	1
		%	4	0	4
N0		*n*	2	0	2
		%	9	0	9
N1		*n*	2	4	6
		%	9	18	27
N2		*n*	4	8	12
		%	18	36	54
	a	*n*	1	1	2
		%	4	5	9
	b	*n*	2	5	7
		%	9	23	32
	c	*n*	1	2	3
		%	5	9	14
N3		*n*	0	1	1
		%	0	5	5
Total		*n*	9	13	22
		%	41	59	100.0

Tab. 3 Description of the recorded toxicities stratified for type and grading (*G*)

		n	%
Hematologic toxicity			
Yes		4	18
	Anemia G1	3	14
	Platelet loss G2	1	4
No		18	
Skin toxicity			
Yes		20	90.0
	G1	4	18
	G2	8	36
	G3	8	36
No		2	10
Mucosa			
Yes		20	9
	G1	2	9
	G2	8	36
	G3	10	45
No		2	10
Dysphagia			
Yes		17	77
	G1	12	54
	G2	2	9
	G3	3	14
No		5	23

Tab. 1 Contraindications for radiochemotherapy

Eldery Age ≥ 70 years old
Unfit for limiting performance status Performance status ≥ 2 according to ECOG or Karnovsky Performance Scale ≤ 60
Unfit for limiting comorbidities Functional marrow, liver, and kidney activity limiting for the prescribing of cisplatin

33 fractions: 1.65 and 2.12 Gy per fraction

Conclusion

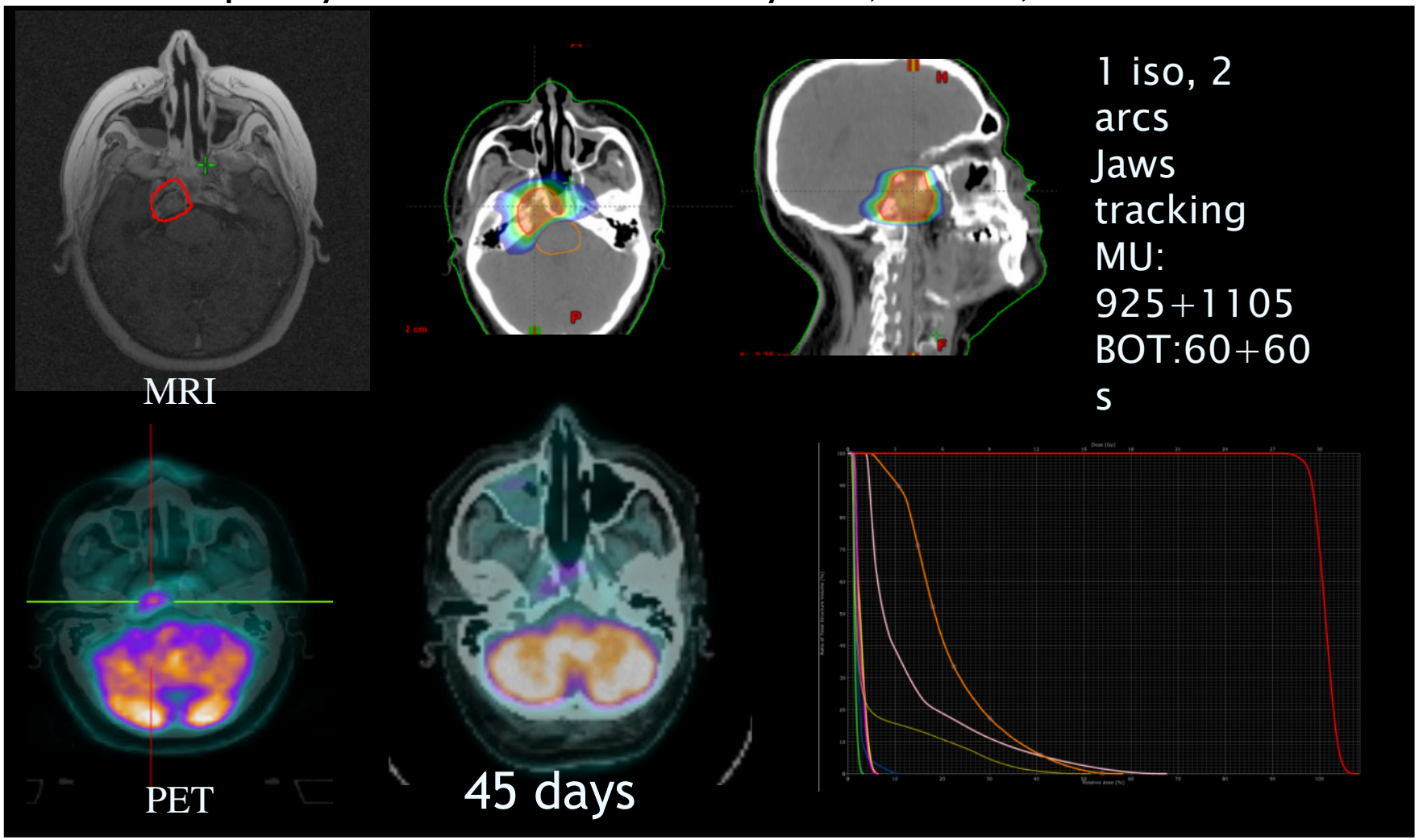
The toxicity data reported here are promising and encouraging in relation to the adoption of moderate hypofractionation with VMAT-SIB techniques. Longer follow-up is necessary to evaluate late toxicities, and definitive outcomes in terms of disease-free and overall survival.

Toxicity evaluation and follow-up

Alongi et al. 2012

Head and Neck: what next? TrueBeam and FFF!

Nasopharynx re-treatment: 6Gy x 5; 10FFF; DR 2400.



Does RapidArc play a role in Lung cancer?

Verbakel et al. Radiother. Oncol. 2009

Ong et al. Radiother Oncol 2010;97:431

Scorsetti et al. Radiat. Oncol. 2010

Ong et al. Radiother. Oncol. 2010;97:437

Ong et al. IJROBP 2011

Palma et al. IJROBP 2011;79

Palma et al. IJROBP 2011;81

Chan et al. Radiother. Oncol. 2011

Kimura et al. IJROBP 2011

Trakul et al. IJROBP 2012

Bree et al. Med. Dosim. 2012

Seppala et al. Radiat. Oncol. 2012

Dehale et al. Radiother. Oncol. 2012

Verbakel et al. IJROBP 2012

SBRT/SABR in early stage lung tumors

Meta-analysis [Grutters JPC 2009]

	CRT	SBRT	Protons
2-year OS* (95% CI)	**53%** (46-60)	**70%** (63-77)	**61%** (47-75)
5-year OS* (95% CI)	**19%** (15-24)	**42%** (34-50)	**40%** (24-55)

**OS: overall survival corrected for % of medically inoperable patients*

CRT = conventional RT
SBRT = sterotactic body RT

Stereotactic ablative radiotherapy (SABR)

Contents lists available at ScienceDirect

Radiotherapy and Oncology

journal homepage: www.thegreenjournal.com

Systematic review

Systemic review of the patterns of failure following stereotactic body radiation therapy in early-stage non-small-cell lung cancer: Clinical implications

Alexander Chi [a,*], Zhongxing Liao [b], Nam P. Nguyen [a], Jiahong Xu [c], Baldassarre Stea [a], Ritsuko Komaki [b]

Table 2
Reported survival outcome and local control in 35 studies; SD = standard deviation.

	# Studies with available data	Mean ± SD	Median (range)
Overall survival (%)			
12 months	15	82.82 ± 11.43	83.00 (52.00–100.00)
24 months	21	64.59 ± 15.49	65.40 (32.00–91.00)
36 months	18	57.67 ± 15.97	55.90 (32.00–91.00)
60 months	9	45.29 ± 20.10	47.00 (18.00–77.50)
Cause-specific survival (%)			
12 months	7	93.67 ± 2.71	94.00 (88.00–96.00)
24 months	15	77.31 ± 9.93	82.00 (53.50–88.00)
36 months	14	72.01 ± 11.96	70.00 (53.00–90.50)
60 months	7	56.89 ± 16.27	50.00 (40.00–78.00)
Local control (%)			
12 months	8	91.81 ± 3.53	92.00 (85.30–96.00)
24 months	11	86.90 ± 9.68	88.00 (67.90–96.00)
36 months	11	80.62 ± 13.57	84.00 (57.00–95.00)
48 months	1	89.00 ± 0.00	89.00 (n/a)
60 months	1	86.00 ± 0.00	86.00 (n/a)

Local control rates ≥90%
[Chi A, 2010]

Serious toxicity uncommon
[Chi A, 2010]

Quality of life maintained
[van der Voort van Zyp N; Senan S, 2010]

Limited decline in pulmonary function
[Henderson M, 2008; Stephans KL, 2009; Phernambucq E, 2011]

SBRT: RA with FFF modality

What RA brings:
- Dose conformity to the tumor
- Sparing of healthy tissue

What Flattening Filter-Free Beams (FFF) brings:
- Reduction peripheral dose
- Higher dose rate
- Much higher dose per pulse
- Significantly faster RT

IMPROVING TIME EFFICIENCY FOR DELIVERY
POTENTIAL RADIOBIOLOGY IMPLICATIONS
MOST IMPORTANT IN SBRT

SBRT VMAT with FFF in NSCLC Stage I

PURPOSE

to evaluate preliminary clinical results and pulmonary toxicity

METHODS AND MATERIALS:

46 patients median age 75 years (58-89 years) M 28 F 12

Stage IA 34 (64%) IB 6 (36%)

CT scan and CT-PET with 18FDG

A pathological diagnoses was available for 18 patients (50%)

Mean CTV: 16 mm

RapidArc with FFF: 4 x 12 Gy

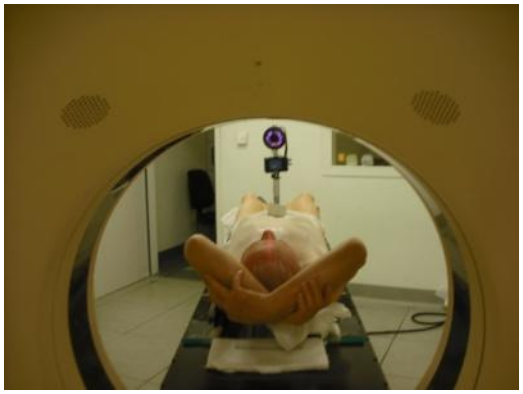
Control group: 86 patients treated with 3DCRT

Navarria et al. Radiother. Oncol. At press

SBRT VMAT with FFF in NSCLC Stage I

PROCEDURE

- Thermoplastic masks for the thoracic region
- CT scan from the mandible to the L3 with 3 mm slice thickness in free breathing mode
- 4D-CT scan to evaluate organ motion



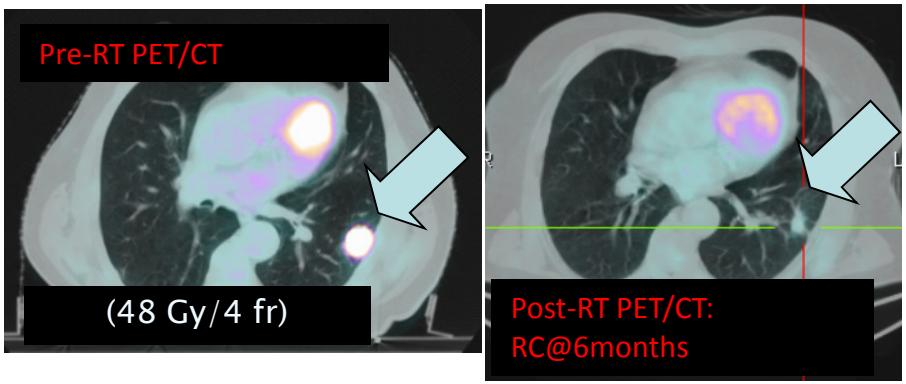
TREATMENT PLANNING

- GTV: lesion
- CTV: Personalized margins in relation to the respiratory motion
- PTV: CTV + 4-5 mm
- Total Dose: 48 Gy in 4 fractions

- CBCT every day

Navarria et al. Radiother. Oncol. At press

SBRT VMAT with FFF in NSCLC Stage I



Toxicity RA-FFF
G1-2: 8/46 patients (17.4%)
G3: 2/46 (4%)

Toxicity 3DCRT:
G1-2: 21/86 (24.4%)
G3: 8/86 (9%)

IPSI LUNG	3DCRT-FF	VMAT RA - FFF	p
V5	31.4 % (6.6-57.8)	24.9 % (6.8-54)	0.02
V20	11.8 % (0-26.7)	7.3 % (1.2-26.6)	0.003
MLD	7.2 Gy (0.92-12.6)	4.8 Gy (1.2-13.3)	0.001

Navarria et al. Radiother. Oncol. At press

SBRT VMAT with FFF in NSCLC Stage I

Time of FU (CT)	PD	SD	PR+CR
3 months •3DCRT •VMAT-RA (FFF)	6 7.3% -	28 34% 6 15%	48/82 58.4% 34/40 85%
6 months •3DCRT •VMAT-RA (FFF)	6 7.3%) -	20 24.3% 2 5%	56/82 68.2% 38/40 95%
12 months •3DCRT •VMAT-RA (FFF)	6 7.3%) -	16 19.5% 2 5%	60/82 73% 38/40 95%

Time of FU (FDG_PET)	PD	SD	PR+CR
12 months •3DCRT •VMAT-RA (FFF)	6 9.7% -	4 6.5% -	52/62 83.8% 34/34 100%

Median FY: 12 months

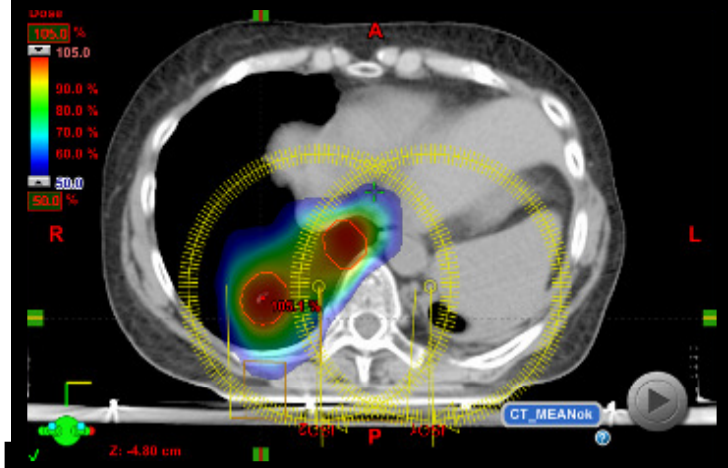
1 yr LC (SD+PR+CR):
92.5 for 3DCRT
100% for RA with FFF

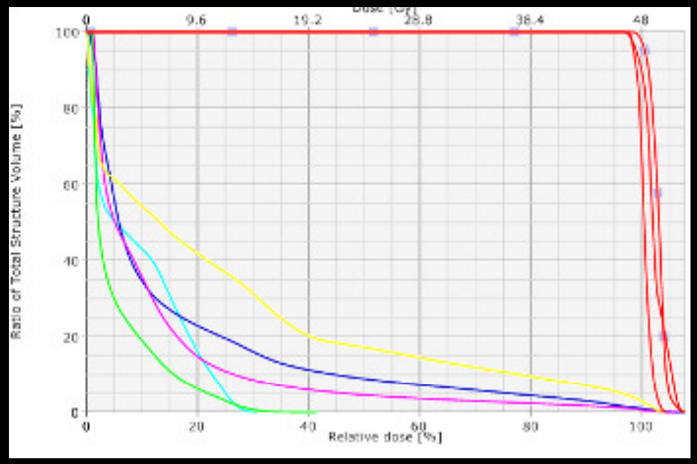
6 patients died for other causes.

Crude OS = 87%
OS (tumor related) = 100%

Navarria et al. Radiother. Oncol. At press

SBRT in lung: 12Gyx4;10FFF;DR 2400.





4D CT

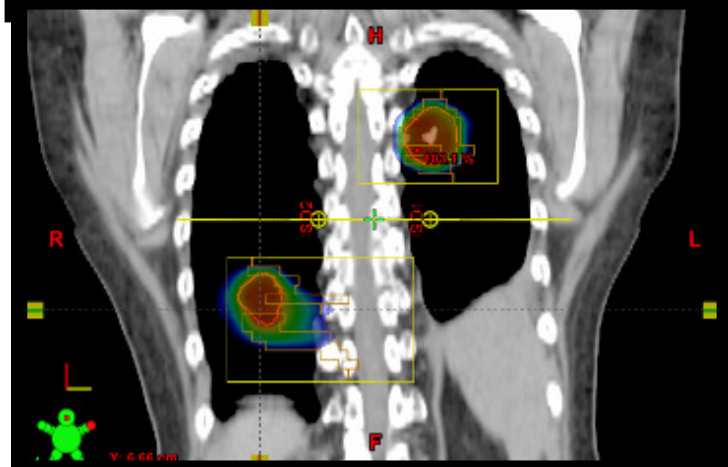
2 isocentres

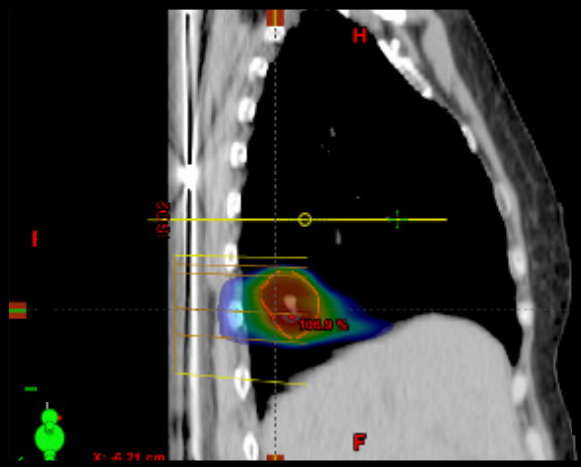
2 full arcs

Jaws tracking

MU: 3014+3606

BOT:75+91s



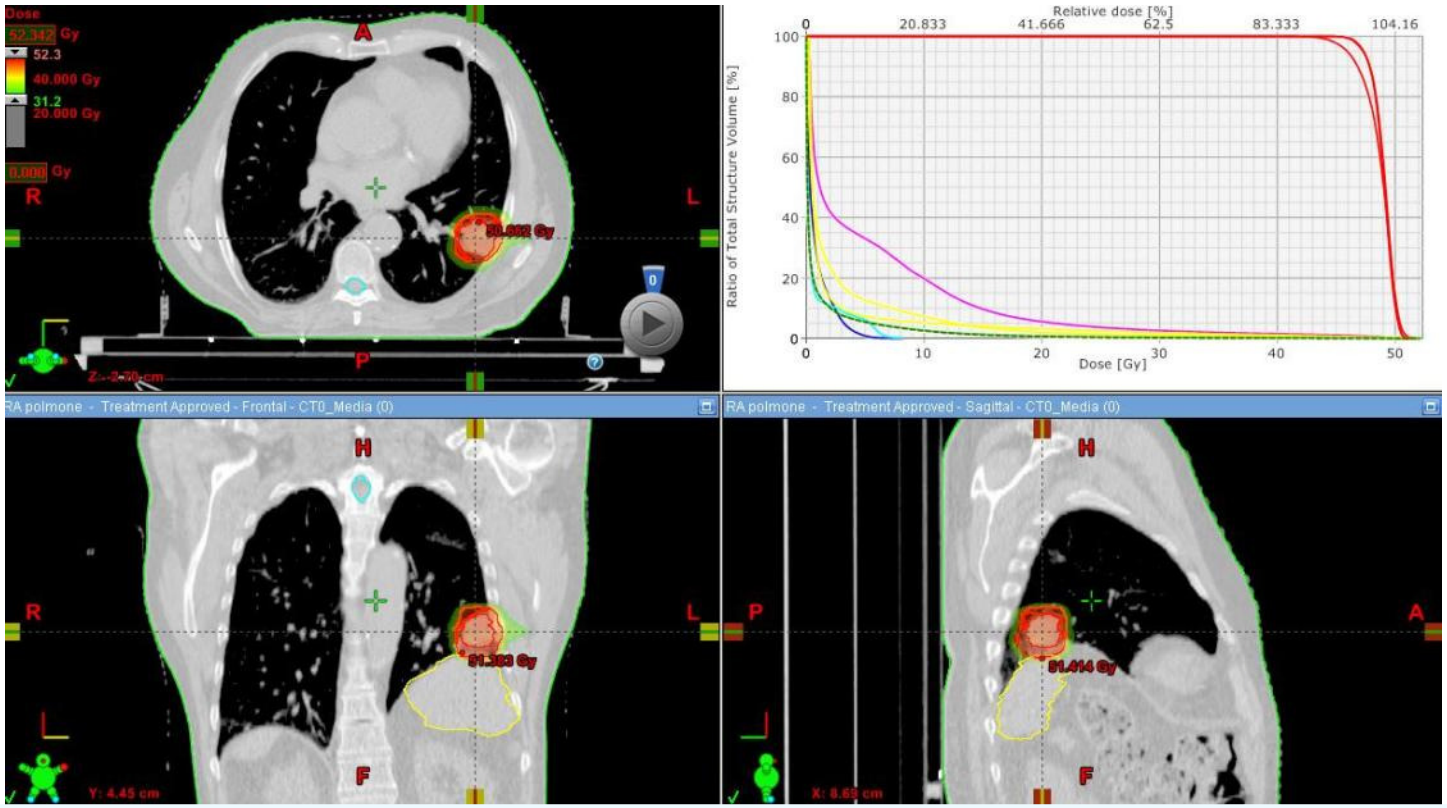


Heart: mean dose = 2.6 Gy

Lung: mean dose = 7.5 Gy (left) 5.7 Gy (right)

Spinal Cord: max dose = 13.0 Gy

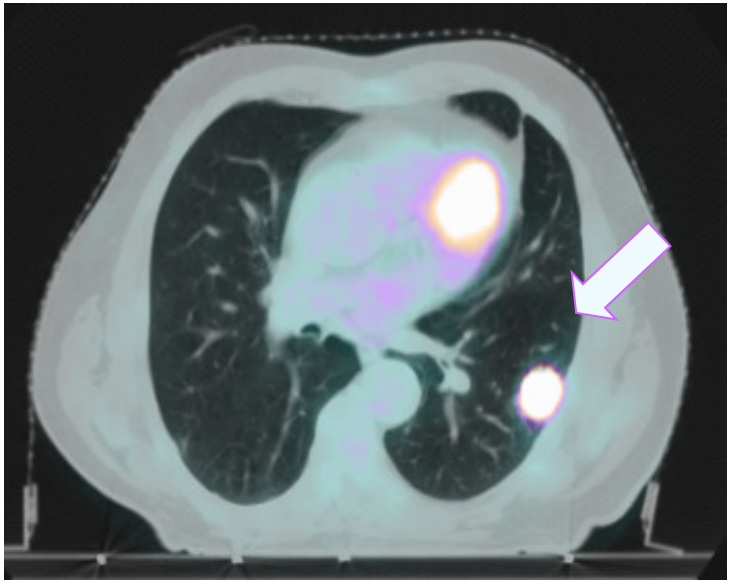
Male 76 years NSCLC Stage IA - 48 Gy/4 fr



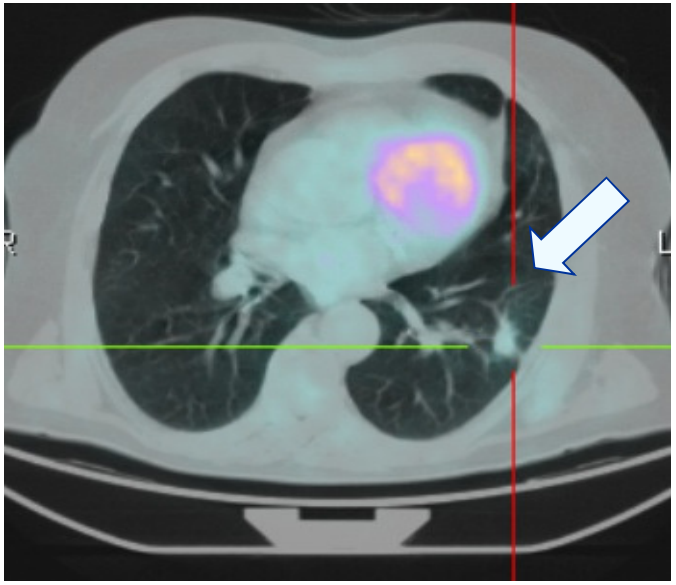
Median beam on time (BOT) was reduced by 75% passing from about 8 minutes (with FF modality) to 2 minutes (with FFF modality):
Increased of patient comfort and Reduction of intra-fraction motion

Male 76 years NSCLC Stage IA - 48 Gy/4 fr

Pre SBRT

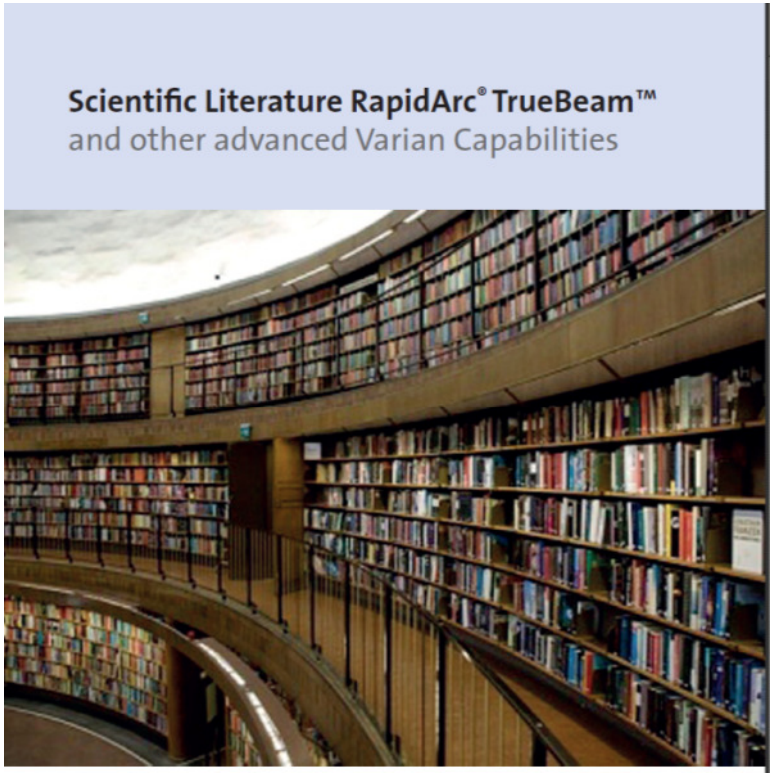


Post SBRT



RESPONSE: COMPLETE REMISSION PET- CT AT 6 MONTHS

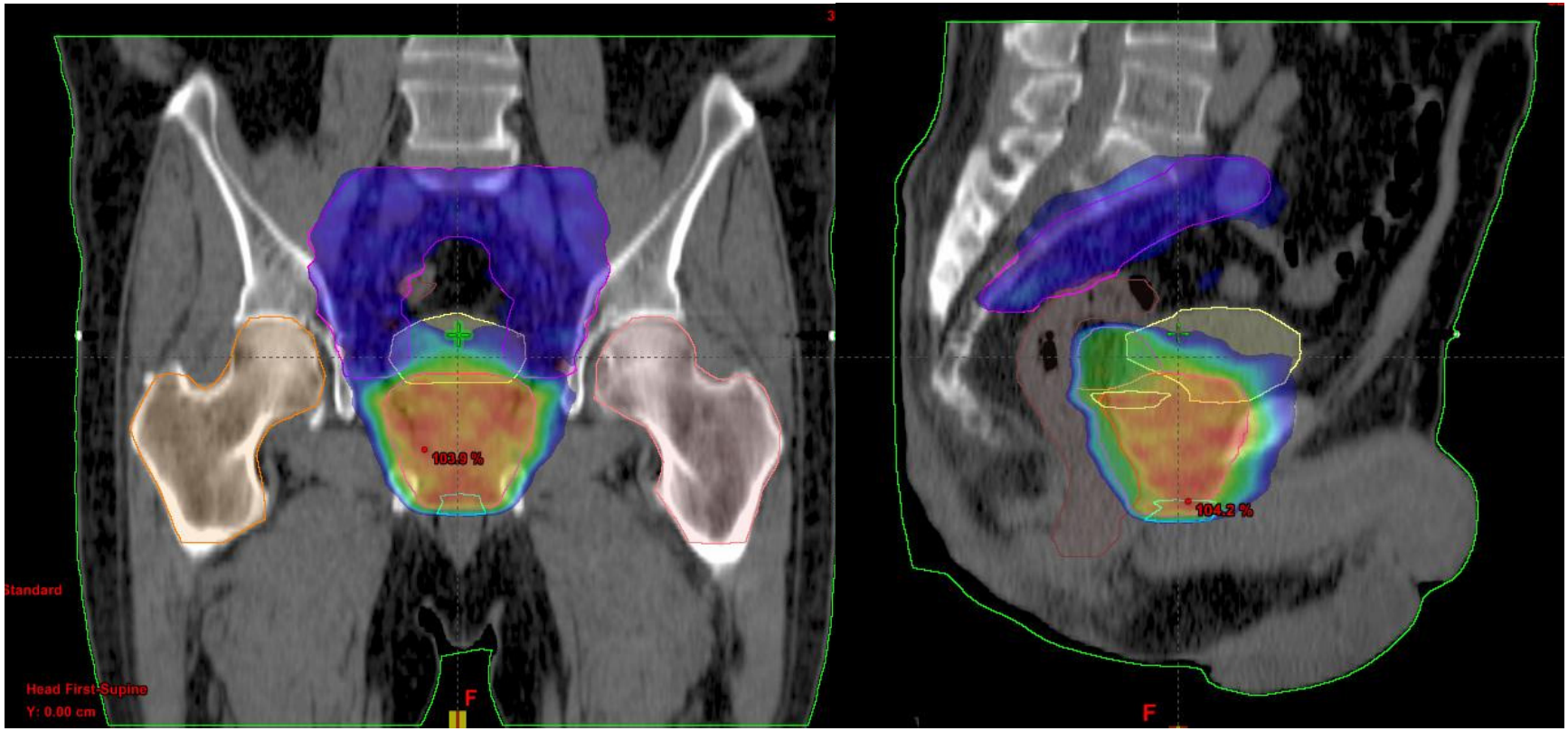
RapidArc, TB and FFF in prostate: scientific literature



Shaffer et al. Clin. Oncol. 2008
Palma et al. IJROBP 2008
Kjaer et al. Acta Oncol. 2009
Weber et al. Radiat. Oncol. 2009
Yoo et al. IJROBP 2010
Pesce et al. Radiat. Oncol. 2010
Jacob et al. Strahl. Onkol. 2010
Aznar et al. Radiother. Oncol. 2010
Reggiori et al. JACMP 2011
Jolly et al. JACMP 2011
Fogarty et al. Radiat. Oncol. 2011
Oliver et al. JACMP 2011
Sze et al Med. Dosim. 2012
Zwahlen et al. IJROBP 2012
Alongi et al. Strahl. Onkol. 2012

Prostate with RA-SIB

74 Gy T – 66 Gy VS - 50 Gy LN



Moderate hypofractionation

F. Alongi[1] · A. Fogliata[2] · P. Navarria[1] · A. Tozzi[1] · P. Mancosu[1] · F. Lobefalo[1] · G. Reggiori[1] · A. Clivio[2] · L. Cozzi[2] · M. Scorsetti[1]

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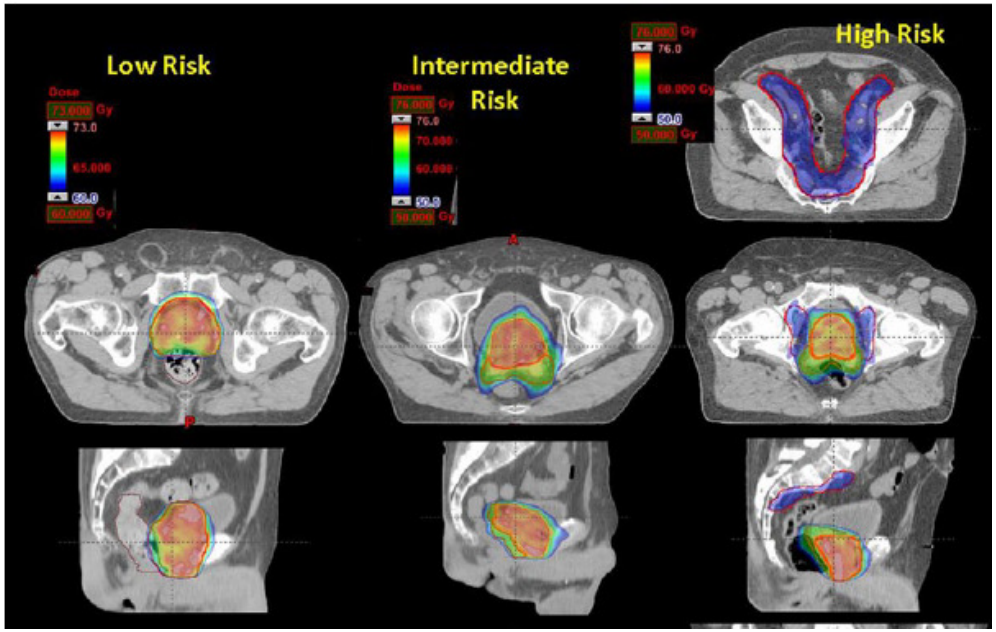
[2] Medical Physics Unit, Oncology Institute of Southern Switzerland, Bellinzona



Moderate hypofractionation and simultaneous integrated boost with volumetric modulated arc therapy (RapidArc) for prostate cancer

All patients were treated in 28 fractions with a moderate hypofractionated schedule:

- low-risk patients received 71.4 Gy to PTV1, i.e., 2.55 Gy/fraction (5 patients also had seminal vesicles (PTV2) irradiation up to 65.5 Gy),
- intermediate-risk patients received 74.2 Gy to PTV1, i.e., 2.65 Gy/fraction and 61.6 or 65.5 Gy to PTV2 exceeding PTV1 (seminal vesicles), and
- high-risk patients received 74.2 Gy to PTV1 (prostate), 61.6 or 65.5 Gy to PTV2 exceeding PTV1 (seminal vesicles), and 51.8 Gy to PTV3 exceeding PTV2 (pelvic lymph nodes).

Tab. 1 Demographic and acute toxicity results

		Low risk	Intermediate risk	High risk	All
Age (years)	Median (range)	75 (60–79)	75 (60–84)	74 (62–82)	75 (60–84)
Stage	Patients (n)	25	34	11	70
Gleason score	Median (range)	6 (4–8)	7 (4–9)	8 (6–10)	7 (4–10)
Initial PSA	Median (range)	6.3 (3–10)	5.8 (3–44)	23.6 (7–40)	6.8 (3–44)

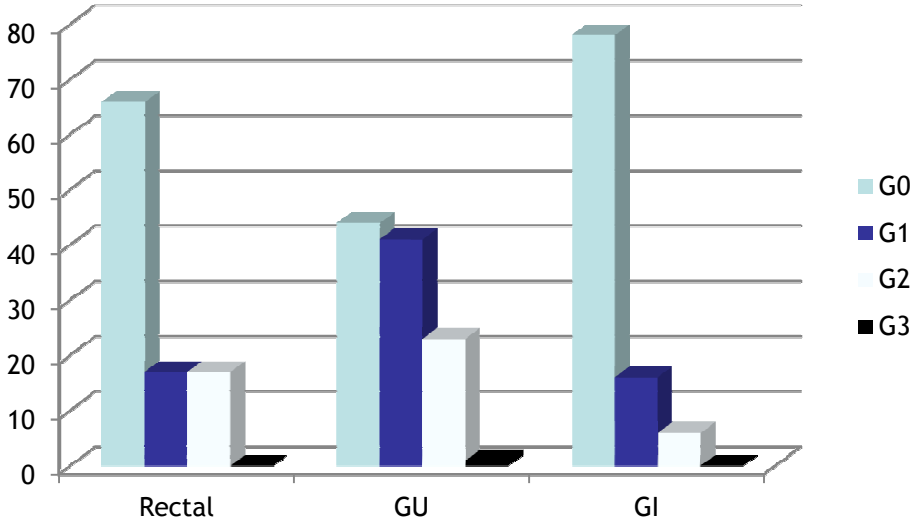
Alongi et al. 2012

Acute Toxicity profile from moderate hypofractionation (70 patients)

- 74.2 Gy in 2.65Gy/fr prescribed in 78% of pts (intermediate and high risk)
- 71.4Gy in 2.55Gy/fr prescribed in 22% of pts (low risk)

		Low risk	Intermediate risk	High risk	All
Age (years)	Median (range)	75 (60–79)	75 (60–84)	74 (62–82)	75 (60–84)
Stage	Patients (n)	25	34	11	70
Gleason score	Median (range)	6 (4–8)	7 (4–9)	8 (6–10)	7 (4–10)
Initial PSA	Median (range)	6.3 (3–10)	5.8 (3–44)	23.6 (7–40)	6.8 (3–44)
Rectal toxicity					
Patients, n (%)	Grade 0	18/25 (72%)	22/34 (65%)	6/11 (55%)	46/70 (66%)
	Grade 1	2/25 (8%)	7/34 (21%)	3/11 (27%)	12/70 (17%)
	Grade 2	5/25 (20%)	5/34 (15%)	2/11(18%)	12/70 (17%)
	Grade 3	0/25 (0%)	0/34 (0%)	0/11 (0%)	0/70 (0%)
GU toxicity					
Patients, n (%)	Grade 0	10/25 (40%)	17/34 (50%)	4/11 (36%)	31/70 (44%)
	Grade 1	7/25 (28%)	11/34 (32%)	4/11 (36%)	22/70 (31%)
	Grade 2	7/25 (28%)	6/34 (18%)	3/11(27%)	16/70 (23%)
	Grade 3	1/25 (4%)	0/34 (0%)	0/11 (0%)	1/70 (1%)
Upper GI toxicity					
Patients, n (%)	Grade 0	22/25 (88%)	26/34 (76%)	6/10 (60%)	54/69 (78%)
	Grade 1	2/25 (8%)	6/34 (18%)	3/10 (30%)	11/69 (16%)
	Grade 2	1/25 (4%)	2/34 (6%)	1/10(10%)	4/69 (6%)
	Grade 3	0/25 (0%)	0/34 (0%)	0/10 (0%)	0/69 (0%)

PSA prostate-specific antigen, GU genitourinary, GI gastrointestinal.



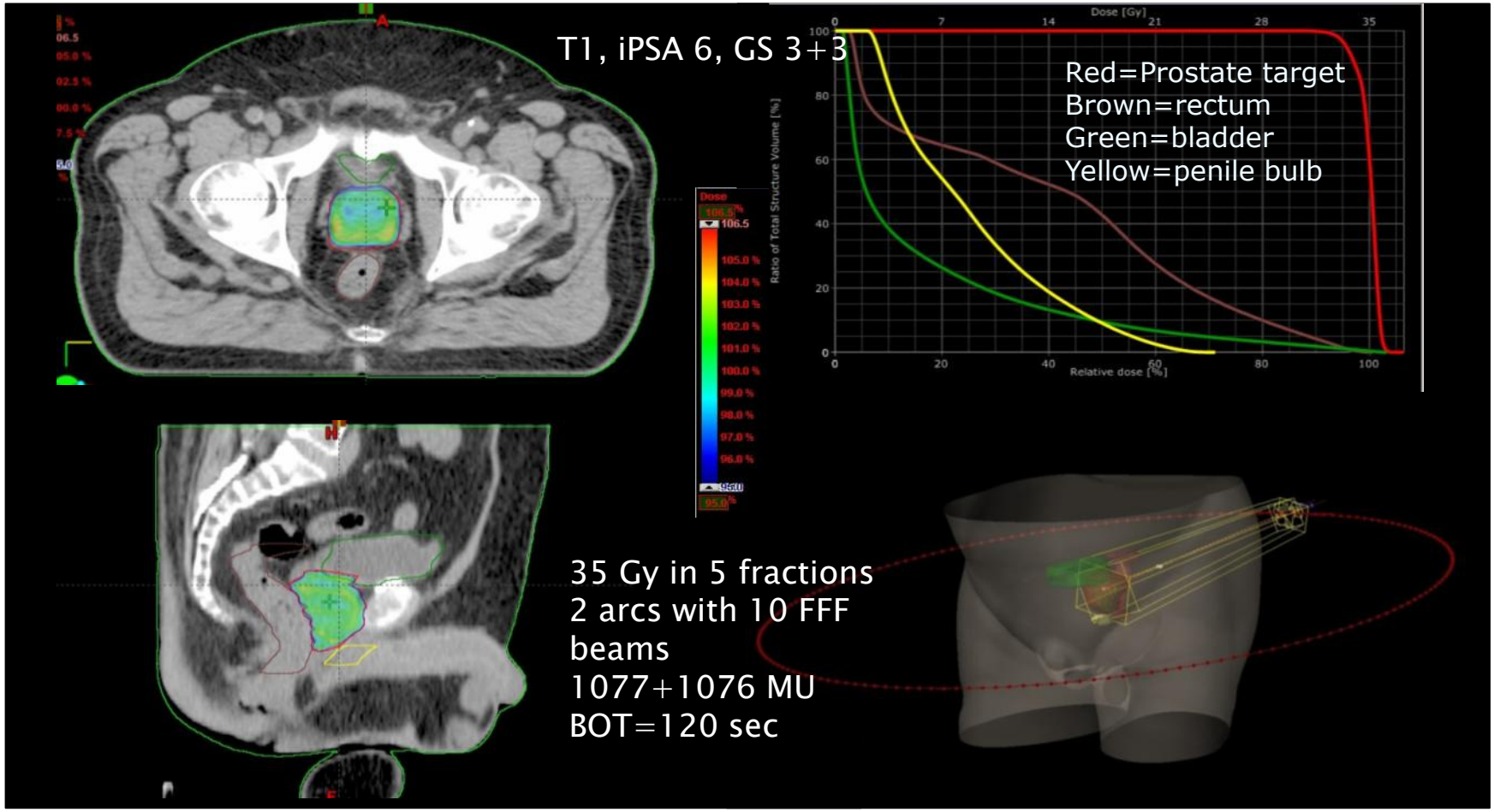
Alongi et al. Strahlen. Onkol. 2012

Extreme Hypofractionation on TB: Phase II trial

ISTITUTO CLINICO HUMANITAS
Istituto di Ricovero e Cura a Carattere Scientifico

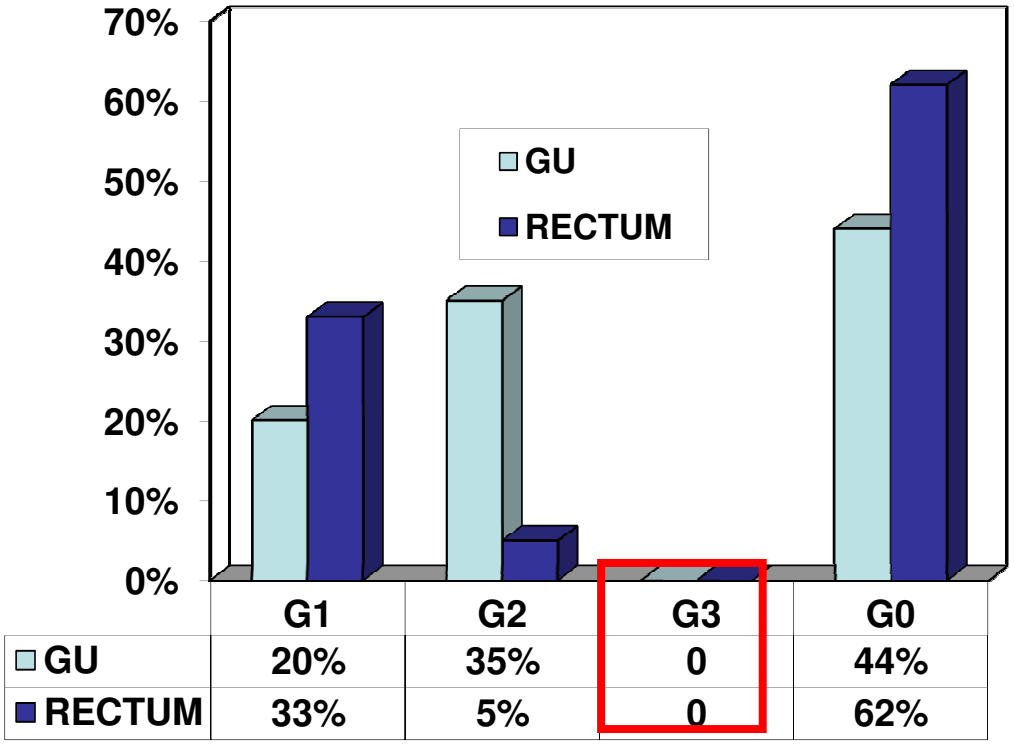
- Age ≤ 80 years
- WHO performance status ≤ 2.
- Histologically proven prostate adenocarcinoma →Any case where prophylactic lymph node irradiation is not required (risk of microscopic involvement ≤ 15%)
- PSA ≤ 20 ng/ml.
- T1-T2 (localized)-stage
- No pathologic lymph nodes at CT/ MR and NO distant metastases
- No previous prostate surgery other than TURP
- No malignant tumors in the previous 5 years
- IPSS 0-7
- Combined HT according to risk factors.
- Informed consent

Extreme Hypofractionation on TB: Phase II trial



Extreme Hypofractionation on TB: Phase II trial

N Patients recruited	34
GS (median)	6(6-7)
iPSA (median)	6(0.50-12)
Dose prescribed	35 Gy in 5 fractions
BOT(median)	106(64-120)
Duration in days(median)	11.8(9-22)
F-UP(median)	5(1-9)
N SPACEOAR	9 inplants



	G1	G2	G3	G0
GU	20%	35%	0	44%
RECTUM	33%	5%	0	62%

ESTRO 2013 Accepted

LIVER: SBRT with RapidArc and FFF

Liver:

Yin et al. Med. Dosim. 2011

Viellot et al. Radiat. Oncol. 2011

Kuo et al. Radiat. Oncol. 2011

Reggiori et al. Med. Phys. 2012

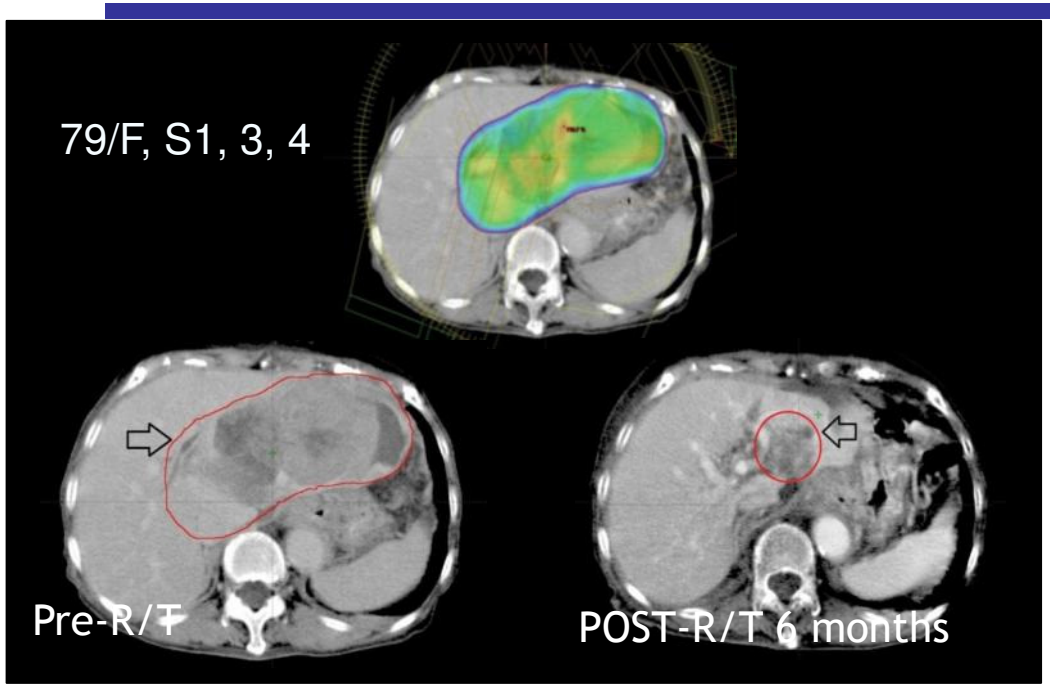
Gong et al. Strahl. Onko. 2012

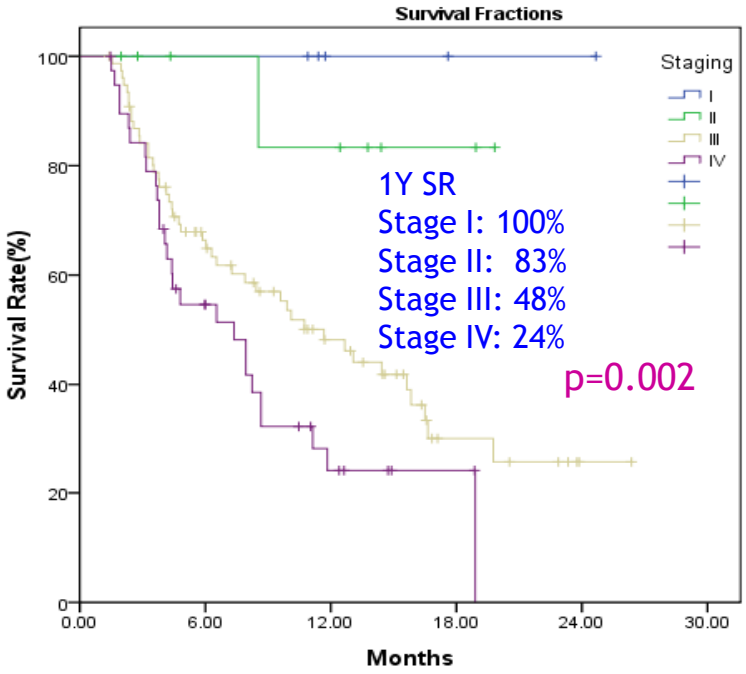
Mancosu et al. Radiat. Oncol. 2012

Wang et al. STO 2012 at press

Wang et al. Radiat. Oncol. 2012

Primary hepatic ca: Preliminary Results on 138pts





- Response rate: 65%
- 1 Y survival rate: 45.5%
- Mean survival: 13.5 mo
- RILD: G1-2: 24, (18%); G3-4: 10 (7%)

Wang et al. Radiat. Oncol. 2012

Primary hepatic ca: Phase I-II monoinstitutional trial.

Risk adaptive fractionation regimen

For tumor size <3cm and good liver reserve:

15-20Gy * 3 fractions

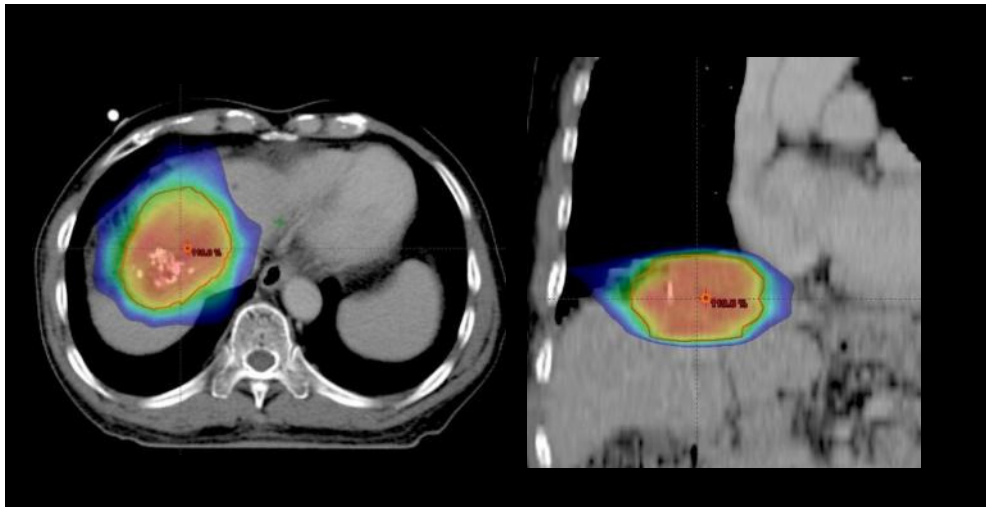
For tumor size between 3-5cm or not enough liver reverse:

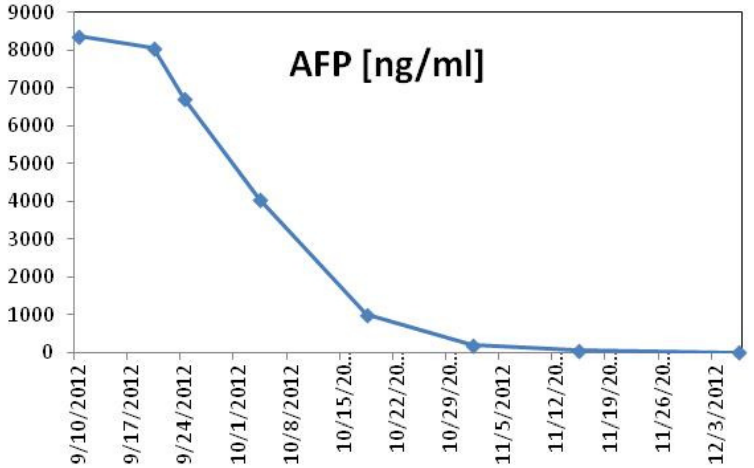
8-120Gy*5 fractions

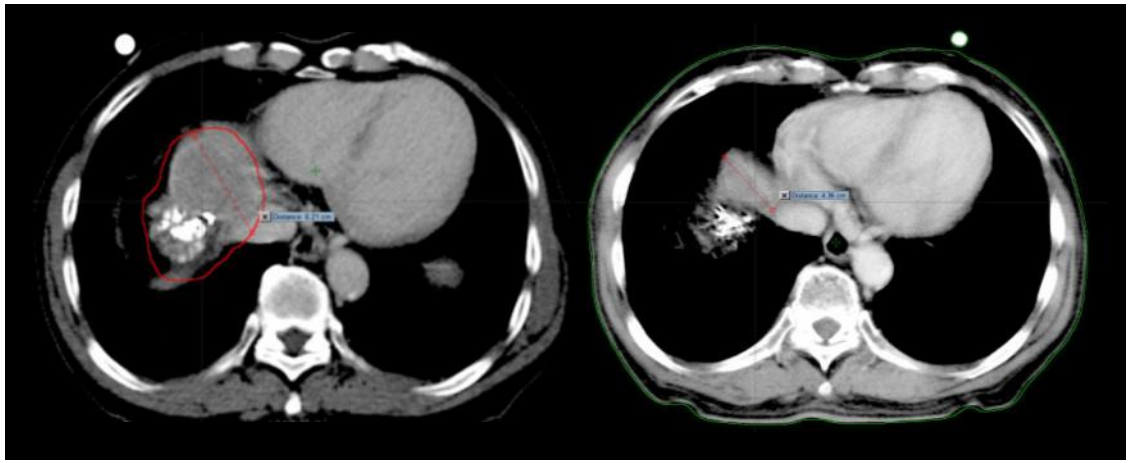
For tumor size more than 5 cm:

5-5.5Gy*10 fractions

Primary hepatic ca: moderate hypofractionation







70 yo man,
T3bN0M0 (stage IIIB), Okuda stage I,
BCLC stage C, Child-Pugh stage A

55 Gy in 10 fractions
RA with TB. 10MV FFF. ~90 seconds

Courtesy dr. Wang, Taipei, Taiwan

Liver Metastases: Rationale for SABR

Table 3. Prospective Trials of Stereotactic Body Radiation Therapy for Hepatic Metastases

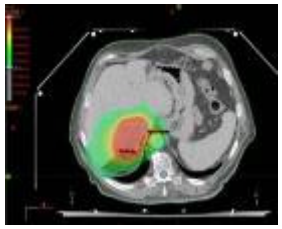
Study	No. of Lesions	Fractionation	Median Follow-Up	Actuarial Local Control	
				Time	%
Herfarth et al[6]	55	1 × 14 Gy to 1 × 26 Gy	6 months	18 months	67
Hoyer et al[24]	141*	3 × 15 Gy	4.3 years	2 years	79
Milano et al[21]	293†	10 × 5 Gy	41 months‡	2 years	67
Mendez-Romero et al[25]	45	3 × 12.5 Gy§	13 months	2 years	82
Rusthoven et al (this study)	49	3 × 20 Gy	16 months	2 years	92

*Total number of colorectal cancer metastases; 44 liver metastases.
†Total number of lesions treated; 45% of patients were treated for hepatic metastases.
‡In surviving patients.
§Different fractionation (3 × 10 Gy or 5 × 5 Gy) used for patients with hepatocellular carcinoma or with lesions ≥ 4 cm.

Liver metastasis treatment in ICH
Radioablation

RAPID ARC → From 50 Gy to 75 in 3 fr.

TRUE BEAM (FFF) → 75 Gy in 3 fractions



Prospective Phase II study of Stereotactic Body Radiation Therapy (SBRT) for liver metastases

END POINTS

- PRIMARY: in field local control
- SECONDARY: toxicity (CTCAE3), progression-free survival and overall survival

INCLUSION CRITERIA

- Inoperable or medically unsuitable for resection
- Maximum tumour diameter < 6cm
- ≤ 3 discrete lesions
- Performance status 0-2
- Good compliance to treatment

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Prospective Phase II study of Stereotactic Body Radiation Therapy (SBRT) for liver metastases

Patients characteristics	Value
No. of patients	**61**
Age (y)	65 (range 39 – 87)
Sex (male:female)	26:35
Baseline KPS	> 90
Prior liver-directed therapy	21% (12 pts)
Primary site	29 Colon 11 Breast 7 Gyn 14 Other sites
Extrahepatic disease	34% (21 pts)

Treatment charateristics	Value
No. of lesions	**76**
Diameter < 3cm	45 (60%)
Diameter > 3cm	31 (40%)
No. of lesions per patient	1 for 48 pts (79%) 2 for 11 pts (18%) 3 for 2 pts (3%)

	Total Dose	
Full	**75 Gy**	**55 (72%)**
Dose - 10%	**67.5 Gy**	**6 (8%)**
Dose - 20%	**61.89 Gy**	**4 (5%)**
Dose - 30%	**56.25 Gy**	**11 (14%)**

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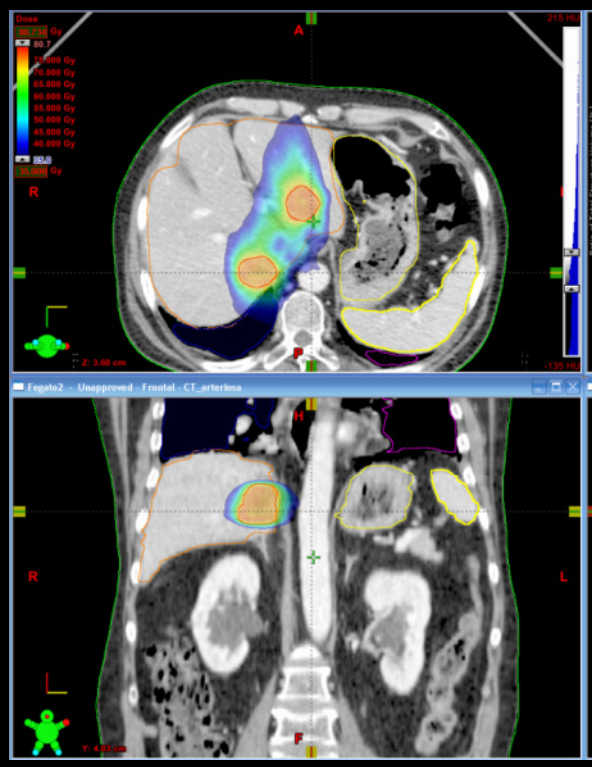
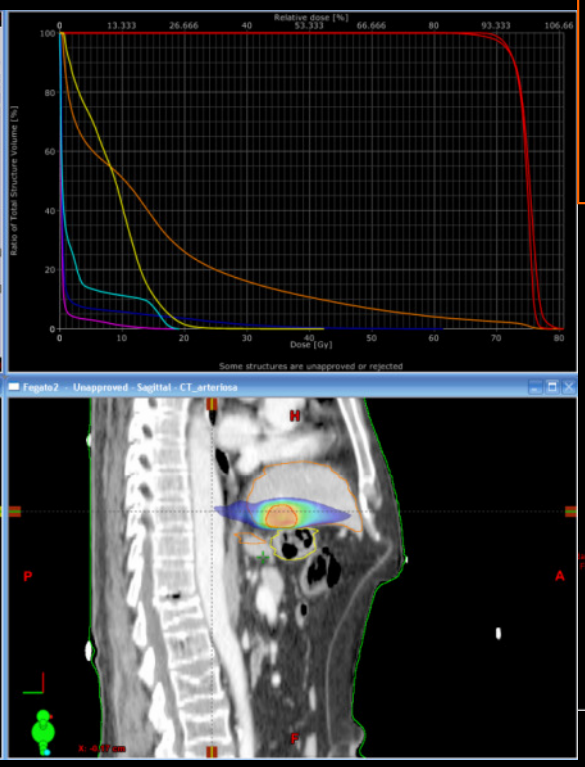
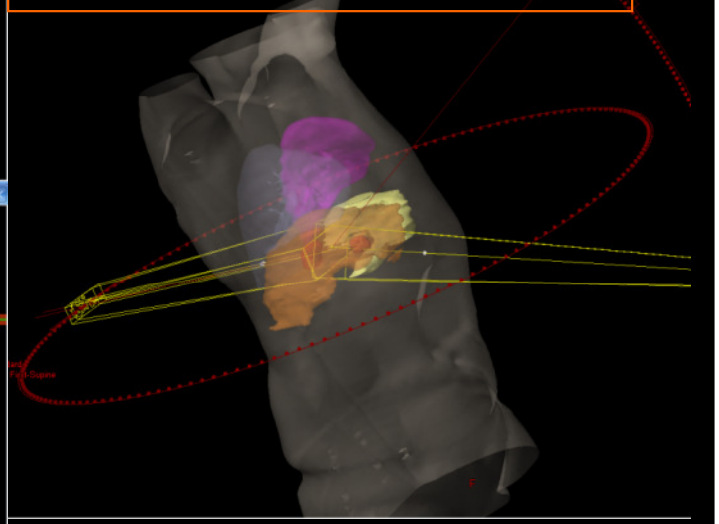
SABR for liver mets with FFF beams





SBRT liver: 25Gy x 3;
10FFF; DR 2400



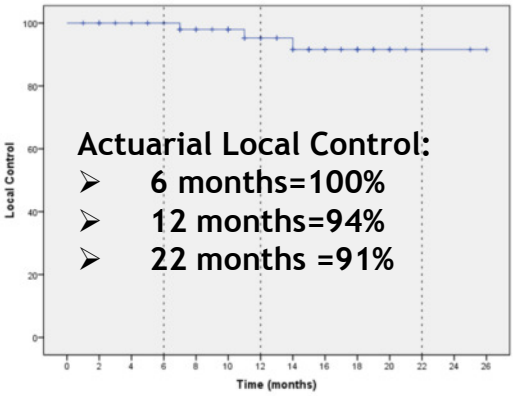
PTV1&PTV2: V95%=99.5%
Spinal cord: Max dose=17.3 Gy
Stomach: Max=21.0Gy, Mean=9.5 Gy
Liver: Mean=15.5 Gy, D15Gyfree=2811cc

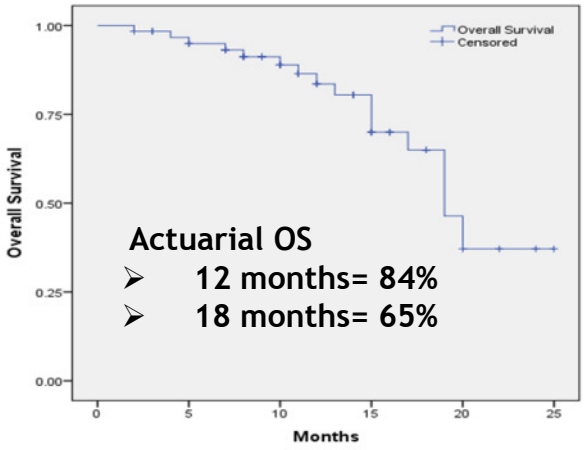
1 isocentre, 3 arcs
Jaw tracking

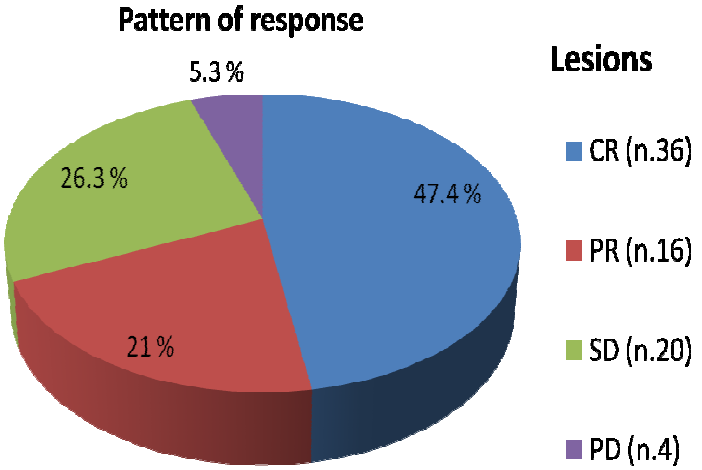
MU:3216+3527+563
BOT: 174s(80+82+14s)

Scorsetti et al. IJROBP 2013

Humanitas: SABR for metastatic liver (RA with FFF): IJROBP 2013







ACUTE TOXICITY:

- **G2 toxicity 4 %**
- **G2 transient transaminase increase 26%**
- **No G3-G4 or G5 toxicity observed**

NO RILD

Median OS rate was 19 months

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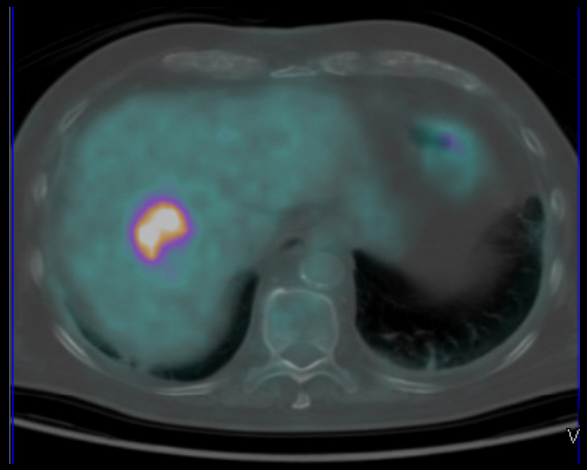
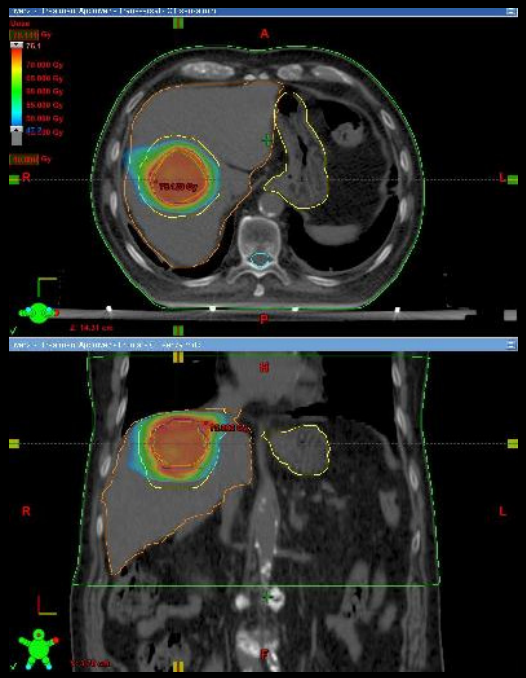
FU: SBRT 25Gy x 3; 10FFF; DR 2400.

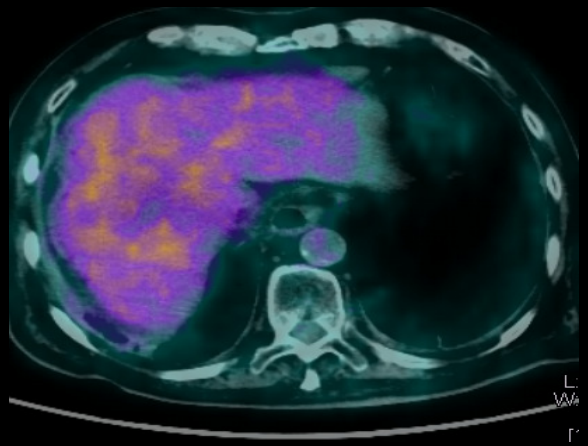
PET pre



RapidArc
1isocentre
2 arcs
Jaw tracking



PET after 6 months



MU: 2953+2955
BOT: 150 sec

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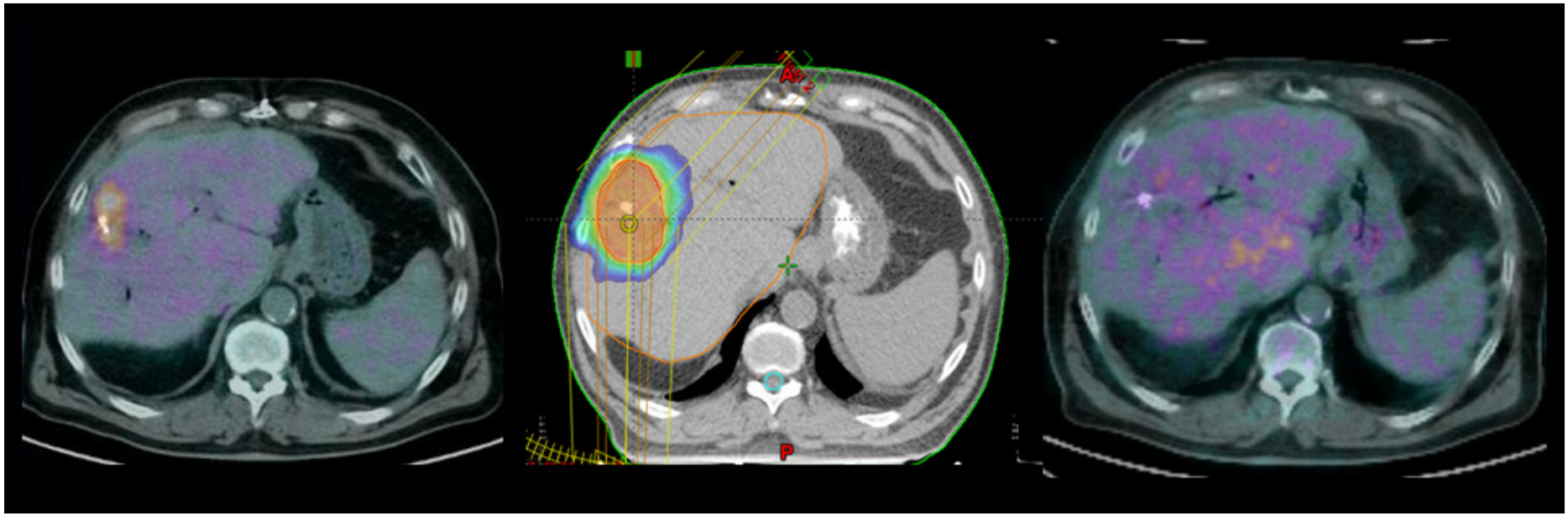
SABR 25Gy x 3; 10FFF; DR 2400.

Patient treated with SBRT for local relapse after hepatic surgery for colorectal metastasis



PET -CT pre-treatment, CEA 72

PET -CT post-treatment CEA 2.2

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Thank you for your interest and attention