Clinical and dosimetric outcomes of Stereotactic MR-guided adaptive radiotherapy (SMART) reirradiation for liver metastases

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Background

Stereotactic ablative body radiotherapy (SABR) is a well-established treatment for oligometastatic liver metastases, however, up to 50% of patients develop further intra-hepatic progression[1].
Limited data exist on liver SABR reirradiation (re-SABR). SMART with daily plan adaptation is an optimal approach for delivering treatment in the upper abdomen[2,3]. This study evaluated the dosimetric outcomes, safety and local control (LC) following SMART re-SABR for liver metastases.

Methods

Re-SABR of liver metastases delivered with SMART (*MRIdian Linac, ViewRay Systems Inc, OH*) were included in this single-centre retrospective analysis.

Reirradiation criteria included:

- Up to 4 metastases
- No tumour size limit
- Uninvolved liver volume ≥ 700cc
- Child-Pugh score ≤ B7

Treatment aims were classified according to reirradiation and oligometastatic ESTRO-EORTC consensus[4,5]. OAR tolerances were calculated per UK SABR Consortium reirradiation guidelines.

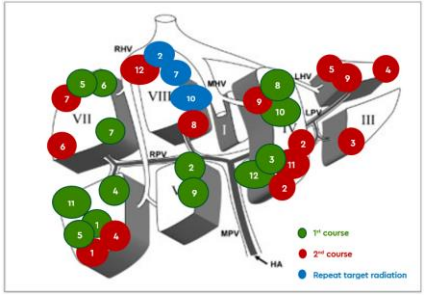

Figure 1: Diagram of the lesions' distribution across hepatic segments

Results

Between October 2020 - April 2024: **12 patients with 18 liver lesions** *(Fig 1)* underwent SMART re-SABR:

- 75% of patients also were treated with SMART for their first SABR course
- **Colorectal cancer (CRC)** was the most common histology (**66,7%**)
- **58.3%** of patients received prior additional liver-directed-treatment such as **surgery or RFA**
- All lesions were categorised as **repeat or induced oligometastases**
- In **four cases, multiple** liver metastases were re-irradiated simultaneously
- The median **interval** between courses was **16.5 months** (6-37 months)

Dosimetric Parameters:

- All mandatory OAR constraints were met
- Median **PTV V(100%) was 95%** (SD 7.6) and **PTV D(95%) was 40Gy** (SD 11.4)

	Dose (Gy) m (range)	BED_{10} m (range)	GTV vol (cc) m (range)	PTV vol (cc) m (range)	Met size(cm) m (range)	MLD (Gy) m; SD (range)	Liver D (700cc) m; SD (range)
1st	50 (40-60) in 3-5#	100 (72-151)	8.12 (2.76-98.5)	40.9 (13.4-180.5)	3.4 (2-9)	6.21 4.0 (0.5-13.2)	6.21 4.0 (0.5-13.2)
2nd	45 (30-60) in 3-5#	100 (48-132)	13.1 (1.87-71.8)	33.4 (9.8-141.1)	3.5 (1.7-9)	6.1 3.1 (2.8-13.5)	1.9 2.5 (0.2-8)

Median-follow-up from reirradiation was **10 months (3-33m).** At analysis from reirradiation:

- 58% were alive and 42% died from disease progression
- **Radiological response = 88.9%** (16/18 liver metastases)
- **One patient relapsed in-field**. Intrahepatic out-of-field recurrence was main pattern of failure (75%), while 58% had distant relapse (lung 41.7%)
- **median OS and 1-year OS** from re-SABR **was 22 months and 71.3%.** No differences between CRC and other histologies for PFS (p=0.90), neither for OS (p=0.69)*(Fig2 and Table)*

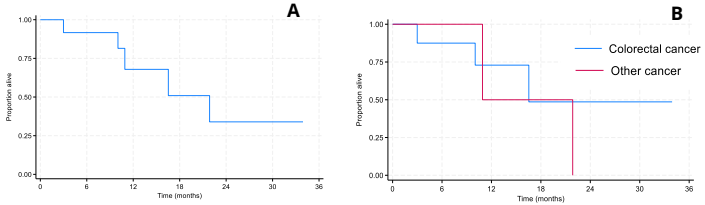

Fig 2. Kaplan-Meier for (A) OS from SMART re-SABR (B) OS by histologies

Reirradiation toxicity profile (CTCAE v5.0) *(Table):*

- Acute G1 was 50% (fatigue 41.7%) and no acute ≥G2
- No liver decompensation was reported
- 1 patient had late G4 colo-hepatic fistula, following liver resection and RFA

Table. Key outcomes compared to the most relevant reports of Liver SABR reirradiation

Platform	Adaptive approach, MRI-Linac		Non-Adaptive approach, CT-based	
	Current cohort	REPAIR[6]	McDuff[7]	Gkika[8]
Patients (lesions)	12 (18)	18 (25) (20 Liver)	49 (64) (23 mets)	24 (30) (12 mets)
Histology	Mets 66.7% CRC	Mets 23.1% CRC	HCC/CCC/Mets 52% CRC	HCC/CCC/Mets
LINAC/RMM	MRIdian® Tracking, Gating	89% MRIdian® Tracking, Gating	Cyclotron (10%) or photons (90%)	Abdominal compression/ 4D-CT
Dose regimens, Gy/# (range)	45/3-5# (30-50) (BED $_{10}$ =100, range 48-132)	41/5 (16–50) (mean BED10=92)	67% SABR:50/5; 54/6. 24% IMRT/3D: 67.5/15 ($EQD2_{10}$ = 65)	48/3-12 (27-66), ($EQD2_{10}$ = 71)
Survival Parameters *(calculate from SABR reirradiation)*				
Median FU, months	10	10.7	10.5	14
LC, %	94.4%	NR	1y 53.6% † (39% for mets)	NR
PFS	2.8months (median)	1y 50%†.	NR	NR
G3-5 toxicity, %	8.3% G4 (1 pt)	0	4.1% G3	1pt G3 bleeding
RILD	0	0	4.1%*	0%

† Entire cohort (no discrimination by group) *HCC

Conclusion

SMART offers unique advantages in a setting of re-irradiation. In our series, SMART re-SABR in oligometastatic liver disease was associated with excellent LC and acceptable toxicity profile. Out-of-field and distant progression rates underscore the need for combining RT with improved systemic including targeted therapies.

References

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