IORT or electronic brachytherapy for liver metastases: dosimetric analyses and clinical possibilities

Gustavo R. Sarria MD, Cas S. Dejonckheere MD

Radiation Oncologists

Klinik für Strahlentherapie und Radioonkologie
Universitätsklinikum Bonn

November 2024

ukb Klinik für Strahlentherapie und Radioonkologie

UNIVERSITÄT BONN

Disclosures

- Personal fees, grants, travel expenses, speaker buro: Carl Zeiss Meditec AG
- Personal fees, travel expenses: MedWave Clinical Trials
- Personal fees: Roche Pharma AG
- Personal fees: AstraZeneca AG
- Travel expenses Guerbet SA

Resected metastases: IORT

ukb Klinik für Strahlentherapie und Radioonkologie

UNIVERSITÄT BONN

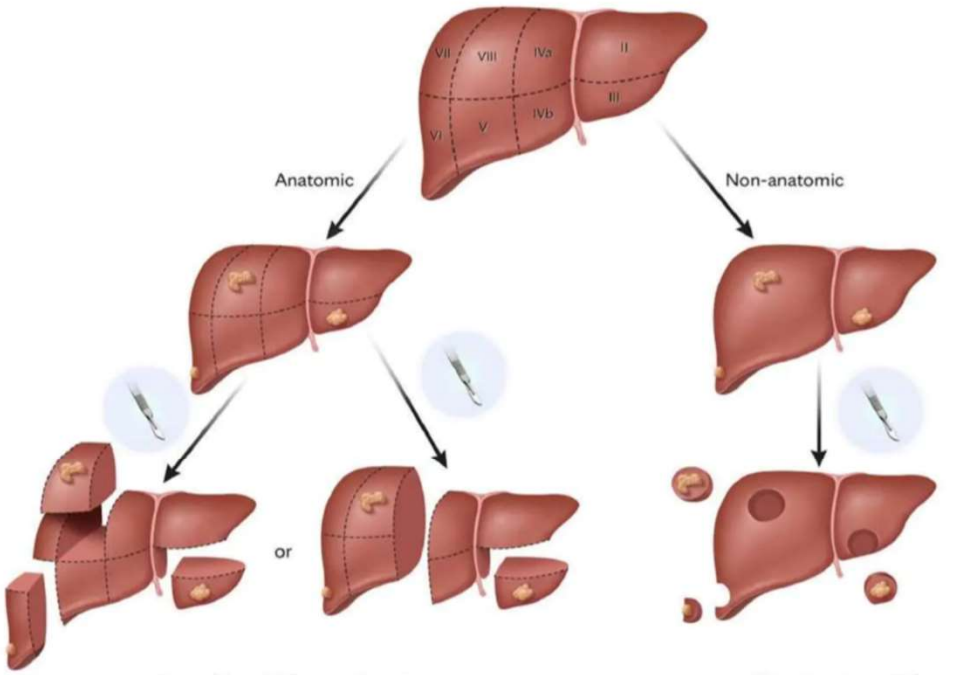
Background

- Liver translate into considerable morbitiy for about 5% of all cancer patients
- In average, 15% survive 1 year after diagnosis
- Their presence limit the option of initiating systemic treatments, which could potentially help prolong the survival outcomes.

Background

- Treatment strategies include surgery, chemotherapy and radiation in different forms
- Surgical interventions have evolved in the past years, with less invasive and radical procedures
- Anatomic or non-anatomic techniques are currently applied
- Non-anatomic approaches spare larger liver volumes, although recurrence rates might be higher

Anatomic vs. non-anatomic



frontiers in Oncology

ORIGINAL RESEARCH
published: 02 December 2021
doi: 10.3389/fonc.2021.767468

Dosimetric Comparison of Intraoperative Radiotherapy and SRS for Liver Metastases

Davide Scafa[1], Thomas Muedder[1], Jasmin A. Holz[1], David Koch[1], Younéss Nour[1], Stephan Garbe[1], Maria A. Gonzalez-Carmona[2], Georg Feldmann[3], Tim O. Vilz[4], Mümtaz Köksal[1], Frank A. Giordano[1], Leonard Christopher Schmeel[1] and Gustavo R. Sarria[1]*

[1] Department of Radiation Oncology, University Hospital Bonn, Bonn, Germany, [2] Department of Internal Medicine I, University Hospital Bonn, Bonn, Germany, [3] Department of Internal Medicine III, University Hospital Bonn, Bonn, Germany, [4] Department of Surgery, University Hospital Bonn, Bonn, Germany

ukb Klinik für Strahlentherapie und Radioonkologie

UNIVERSITÄT BONN

Structure	D_{max}	Volumetric Constraints
Uninvolved liver (liver—GTV)		700 cm^3 <9.1 Gy
Spinal cord	14 Gy	<0.035 cm^3 10 Gy
		<1.2 cm^3 7 Gy
Stomach	12.4 Gy	<10 cm^3 11.2 Gy
Biliary tract		

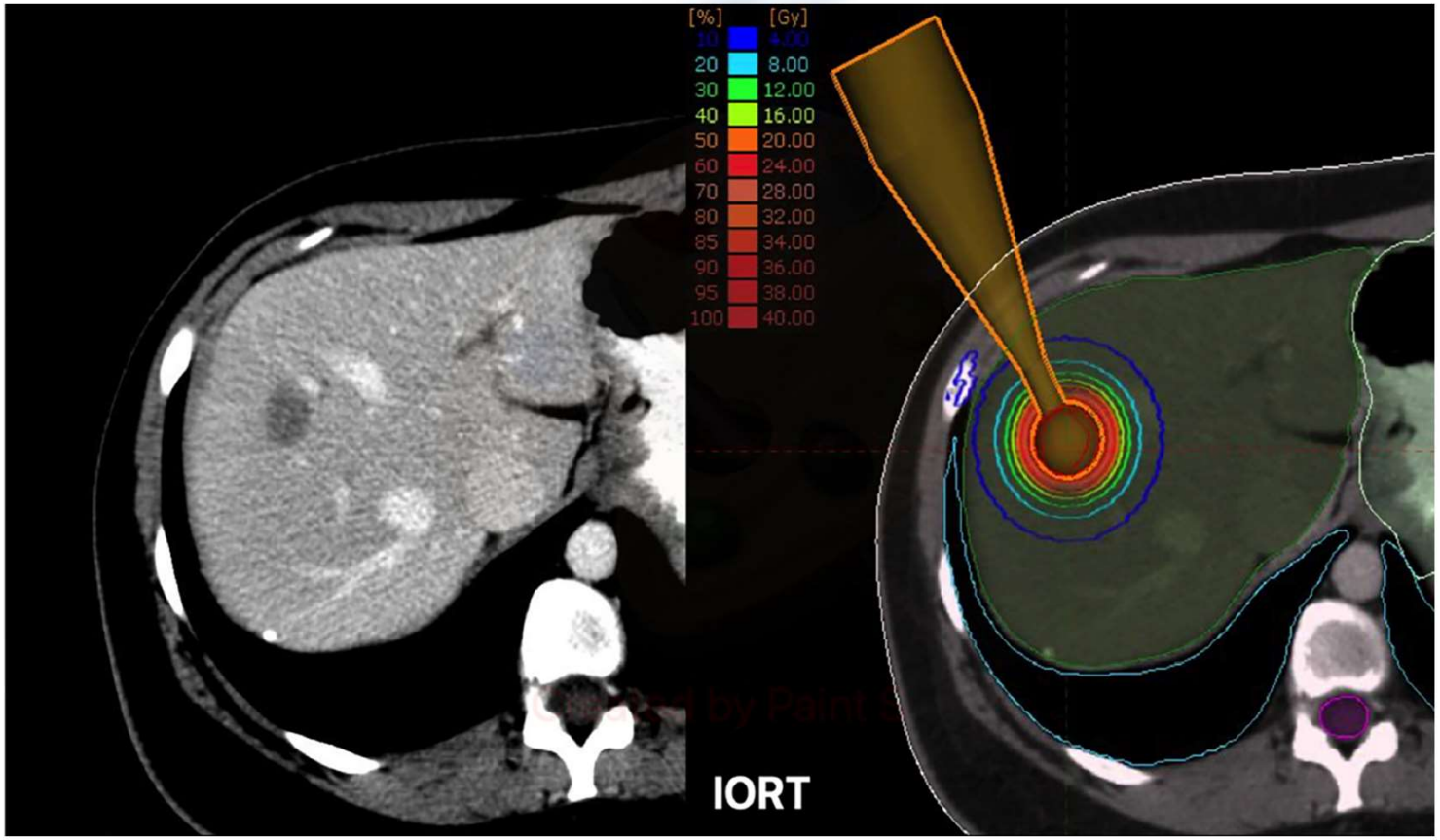
Organs at risk and prede
was defined as 0.035 cn
GTV, gross tumor volum

Structure		Mean	SD
GTV (cm^3)		12.23	12.62
GTV-IORT (cm^3)		19.44	17.26
Liver (cm^3)		2050.97	650.82
Liver-IORT (cm^3)		2031.68	645.05
Liver-GTV (cm^3)		2038.65	648.22
Dosimetric features		**Mean/Median**	**SD/Range**
PTV DIBH-SRS	Volume (cm^3)	30.74	24.64
	D95% (Gy)	39.61	0.68
	D95% (%)	99.03	1.71
PTV FB-SRS	Volume (cm^3)	75.82	45.65
	D95%		
	D95%		
GTV-IORT	D90%		
	D90%		
IORT-Irradiation time (min)			
Applicator diameter (cm)			

Target and liver volumes expressed in cm^3. Target coverage displa
are additionally shown.
GTV, gross tumor volume; IORT, intraoperative radiotherapy; PTV
standard deviation.

Constraints		Mean	SD
Liver V9.1/700 cm^3	IORT (cm^3)	63.39	35.67
	DIBH-SRS (cm^3)	150.12	81.43
	FB-SRS (cm^3)	306.13	128.75
Spinal cord 0.035 cm^3/7 Gy	IORT (Gy)	0.00	0.00
	DIBH-SRS (Gy)	0.00	N.A.
	FB-SRS (Gy)	0.16	0.46
Spinal cord 1.2 cm^3/10 Gy	IORT (Gy)	0.00	0.00
	DIBH-SRS (Gy)	0.00	N.A.
	FB-SRS (Gy)	0.00	0.00
Stomach 10 cm^3/11.2Gy	IORT (Gy)	0.00	0.00
	DIBH-SRS (Gy)	0.00	N.A.
	FB-SRS (Gy)	0.03	0.08
Stomach Dmax 12.4Gy	IORT (Gy)	0.00	0.00
	DIBH-SRS (Gy)	0.00	0.00
	FB-SRS (Gy)	0.00	0.00
Bilary tract 25Gy	IORT (Gy)	2.04	3.25
	DIBH-SRS (Gy)	0.00	0.00
	FB-SRS (Gy)	0.10	0.29

Volumetric or maximum organs at risk exposure for all three explored modalities.
SD, standard deviation; IORT, intraoperative radiotherapy; DIBH, deep inspiration breath hold; FB, free breathing; SRS, stereotactic radiosurgery, NA, not assessable.



ukb Klinik für Strahlentherapie und Radioonkologie

UNIVERSITÄT BONN

Intact metastases: eBT

Background

- Non-resectable/non-operable Liver metastases
- Treatment options include systemic therapies, TACE, HIFU, Y^{90}, MWA
- RT the newcomer? SBRT, HDR – 1- and 5-year LC 95 – 80%
- EBRT-based implies exposure of larger healthy liver volumes. How about minimally invasive procedures?:
  - SBRT vs. HDR vs. eBT

Dosimetric feasibility

- 30 patients previously treated with HDR, 1 x 25 Gy
- Comparison between HDR – SBRT – eBT

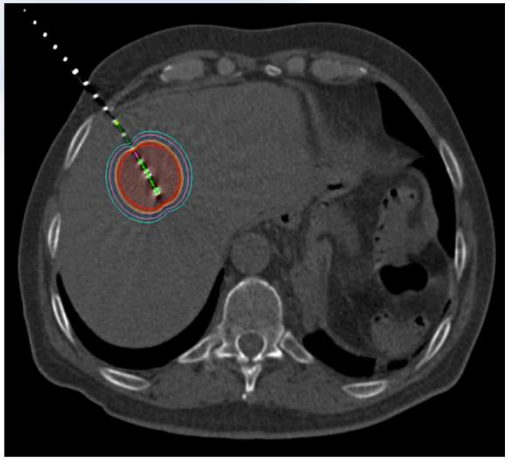
Constraints

OAR	Constraints
Healthy liver (liver – GTV)	700 cm^3 < 9.1 Gy; $D_{66\%}$ < 10 Gy
Biliary tract	D_{max} < 25 Gy
Duodenum	5 cm^3 < 11.2 Gy
Ipsilateral kidney	10 Gy < 33%
Spinal cord	D_{max} < 14 Gy; 1.2 cm^3 < 7 Gy
Stomach	D_{max} < 12.4 Gy; 10 cm^3 < 11.2 Gy
Heart	D_{max} < 22 Gy
Rib	D_{max} < 30 Gy; 1 cm^3 < 23 Gy
Great vessels	1 cm^3 < 27 Gy
Gallbladder	D_{max} < 20 Gy
Bowel	D_{max} < 15.4 Gy
Esophagus	D_{max} < 24 Gy; 1 cm^3 < 15 Gy

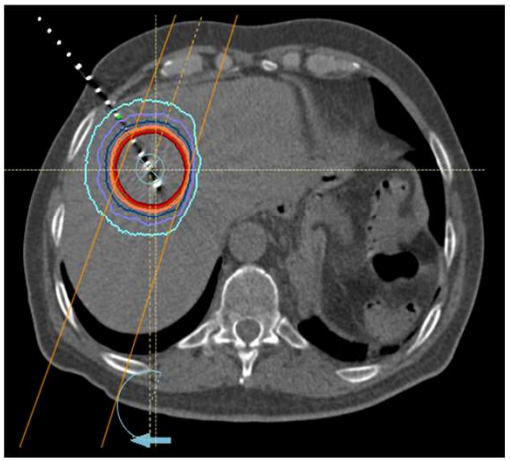
- Dejonckheere et al. Unpublished data

- Baseline

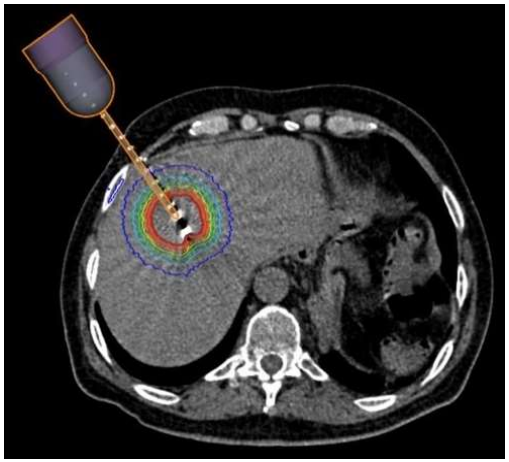
- HDR



- SBRT



- eBT



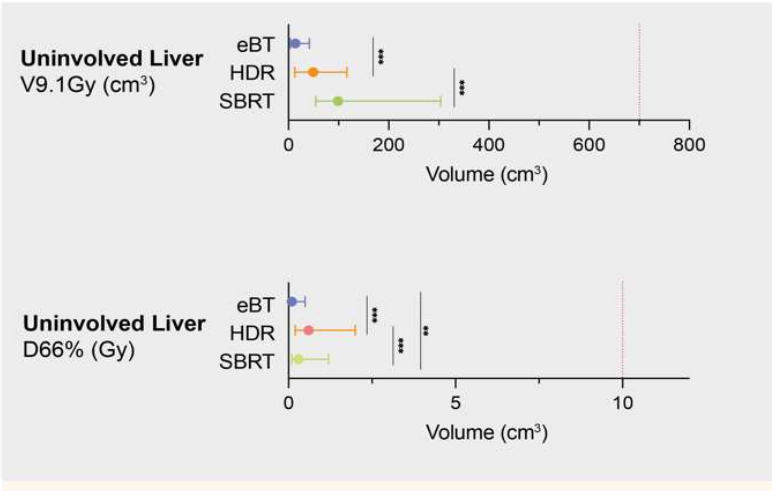
- Dejonckheere et al. Unpublished data

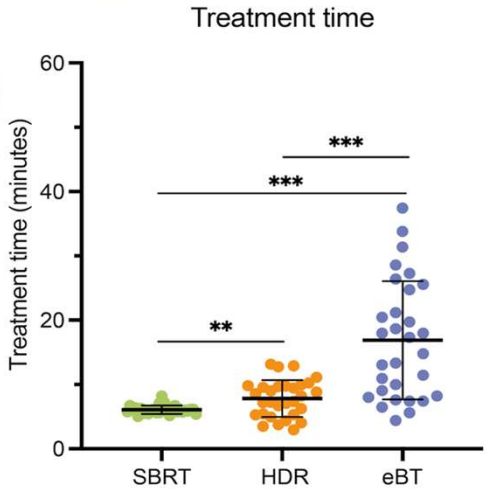
Outcomes

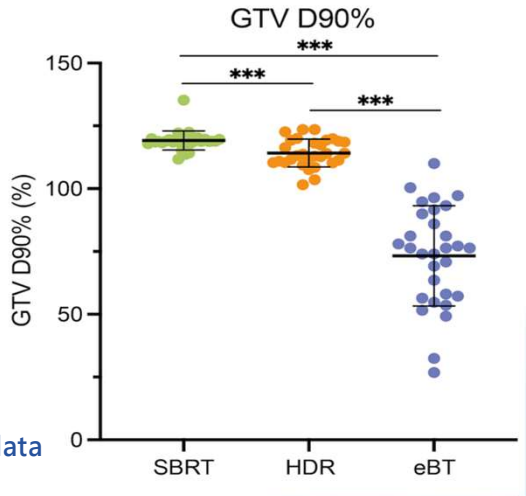
Parameter	Median (range)	p-value
Lesion diameter (mm)	26.7 (15.2–38.2)	
Lesion volume (cm^3)	9.3 (2.5–29.7)	
Uninvolved liver volume (cm^3)	1450.2 (1085.8–2227.2)	
Target volume (cm^3)		
eBT (GTV)	9.3 (2.5–29.7)	> 0.99
HDR (GTV)	9.3 (2.5–29.7)	< 0.001
SBRT (PTV)	25.6 (11.4–59.2)	< 0.001
CTV D98% (Gy)		
eBT	11.4 (3.5–16.5)	< 0.001
HDR	23.1 (19.8–25.7)	< 0.001
SBRT	29.2 (23.2–33.1)	< 0.001
Uninvolved liver V9.1Gy (cm^3)		
eBT	13.8 (3.4–41.6)	< 0.001
HDR	49.2 (12.7–116.8)	< 0.001
SBRT	98.8 (54.3–303.7)	< 0.001

- Dejonckheere et al. Unpublished data

Outcomes







- Dejonckheere et al. Unpublished data

Conclusion

- Lower Liver exposure – lower target coverage
- Multi-dwelling? Ruder et al. 10.5114/jcb.2020.100381
- Patient selection
- Clinical implementation

gustavo.sarria@ukbonn.de

ukb Klinik für Strahlentherapie und Radioonkologie

UNIVERSITÄT BONN