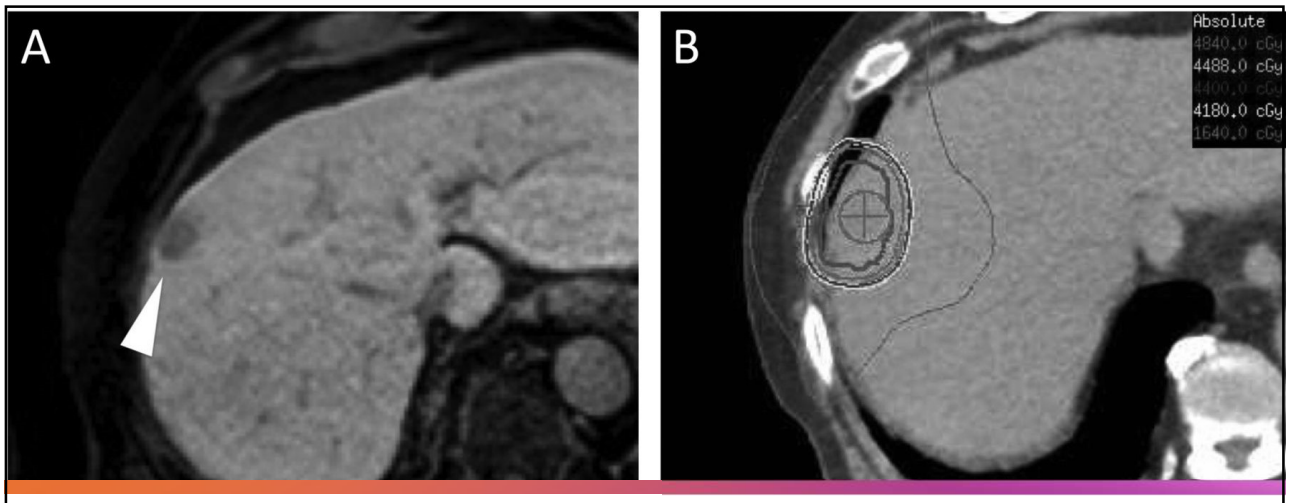

Liver SBRT

Dr Lallemand – Bestro Congress October 25

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Indications

- Hepatocellular carcinoma – unresectable or poor surgical candidates
- Liver Metastases – oligometastatic deseace
- Bridge to liver transplantation
- Alternative when surgery/ablation not feasible

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Prognostic factors

Favorable

- Tumor size < 3-4cm
- Child-Pugh A liver function
- Early-stage disease
- Higher SBRT dose (BED>100 Gy)
- Favorable histology (CRC; Breast)

Poor

- Larger tumor >5cm
- Poor liver function (Child-Pugh B/C)
- Advanced stage
- Low radiation dose
- Multiple lesions

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Patient Selection

Ideal candidates

- Unserectable disease
- Limited disease (<5 lesions)
- Child A or favorable B
- ECOG 0-2
- > 700 ml uninvolved liver
- Controlled extrahepatic disease (for metastases)

Relative Contraindications

- Child C
- Extensive liver involvement
- Active infection or bleeding
- Inability to comply with position/breath-hold
- Tumor abutting bowel !!

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Efficacy

HCC outcomes

Local control rates
- 1 year : 86-96%
- 3 years : 82 – 91%
- 5 years : 76 – 82%

Overall Survival
- 1 year : 73%
- 3 years : 48 – 57%
- 5 years : 40%
- Median OS 22 – 40 months

(Bae et al., 2023; Jang et al., 2019; Rimet al., 2019)

Metastases outcomes

Local control rates
- 2 years : 72-91%
- 3 years : 77 – 93%

Overall Survival
- 2 years : 49 – 67%
- Median OS 20 – 27 months

Best outcomes: colorectal, breast, gynecological primaries

(Mahadevan et al., 2018; Scorsetti et al.,2018; Ohri et al., 2018; Petrelli et al.,2018; Joo et al., 2017)

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Toxicity

Low Severe Toxicity
- Grade ≥3 hepatic/GI toxicity: **3-9%**
- Treatment-related deaths: **Rare**

Radiation-Induced Liver Disease (RILD)
- Risk is **low** with careful patient selection
- Higher risk: Child-Pugh B8/C patients
- Mitigated by dose constraints and motion management

Special Populations
- Safe in patients with prior liver-directed therapy
- Well-tolerated in elderly/comorbid patients
- Low additional toxicity with re-irradiation

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Technical considerations

Dose & Fractionation

- Common regimens: **45-60 Gy in 3-5 fractions**
- Higher BED_{10} (>100 Gy) improves local control for metastases
- Individualized based on tumor size, location, liver function

Motion Management

- Respiratory motion can exceed 2-3 cm
- Techniques: breath-hold, gating, tracking
- Image guidance (CBCT, MRI-linac) essential
- Fiducial markers may be used

Planning Constraints

- Preserve adequate functional liver volume
- Protect organs at risk (stomach, duodenum, bowel)
- Consider baseline liver function

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Dose-Volume Constraints

OAR Constraints

- **Liver (Uninvolved):** A common constraint is to keep at least 700 cc of normal liver below 15 Gy (V15 < total liver – 700 cc) to minimize risk of radiation-induced liver disease (Yadav et al., 2021; Ryuno et al., 2025; Mancosu et al., 2012).
- **GI Tract:** Max dose to 0.5–1 cc of stomach, duodenum, or bowel is typically limited to 21–32 Gy in 3–5 fractions (Sahai et al., 2022; Ryuno et al., 2025;Michel et al., 2017).
- **Central Biliary Tract**: Limiting the volume receiving high BED is important to reduce hepatobiliary toxicity, V40 Gy < 37 cc; V30Gy < 45 cc (Toesca et al., 2017).
- **Kidneys, Spinal Cord, Heart**: Standard SBRT constraints apply, with particular attention to cumulative dose if prior treatments exist (Michel et al., 2017).

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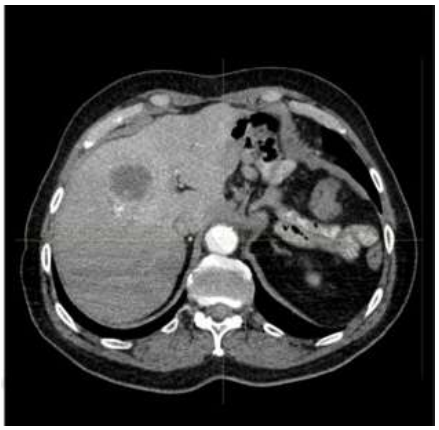
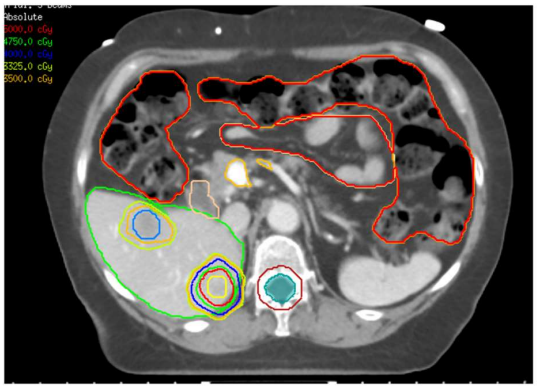
Example





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Radiotherapy technique

- **Imaging and Planning:** Multi-phase CT, MRI, and sometimes PET/CT are used for target delineation. 4D-CT or MR imaging helps account for respiratory motion (Ryuno et al., 2025; Rogowski et al., 2021; Mancosu et al., 2012).
- **Motion Management:** Techniques include abdominal compression, respiratory gating, breath-hold, and real-time MR guidance to minimize target movement and reduce margins (Lee et al., 2023; Crane & Koay, 2016; Rogowski et al., 2021).
- **Delivery Platforms:** SBRT can be delivered using linear accelerators, CyberKnife, or MR-Linac systems (Weykamp et al., 2022; Ryuno et al., 2025; Rogowski et al., 2021; Mancosu et al., 2012).
- **Adaptive Radiotherapy:** Online MR-guided adaptive SBRT (SMART) allows daily plan adaptation, improving target coverage and OAR sparing (Weykamp et al., 2022; Padgett et al., 2020; Rogowski et al., 2021).

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SBRT vs. Other treatments for HCC

Treatment	Local Control	Key Points
SBRT	86-93% (1-3yr)	Comparable to RFA/TACE; superior to sorafenib alone
RFA	~85-90%	Similar outcomes for small tumors (<2 cm)
TACE	~70-80%	SBRT may outperform for medium-sized/recurrent HCC
Surgery	>90%	Gold standard when feasible

Phase 3 Trial (NRG/RTOG 1112):
SBRT + sorafenib: **15.8 months** median OS vs. sorafenib alone: **12.3 months**

Ohri et al., 2018; Mahadevan et al.,2018; Petrelli et al., 2018; Jacksonet al., 2017; Rodríguez et al., 2024;Scorsetti et al., 2018; Alrabiah etal., 2022

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SBRT vs. Surgery : toxicity

SBRT

3-9%

Severe (Grade ≥3) toxicity

- Mostly mild-moderate toxicity
- Fatigue, nausea, transient LFT elevation
- Rare life-threatening complications
- **Outpatient procedure**
- Short recovery time

Surgery

15-30%

Major complications

- Bleeding, infection, bile leak
- Liver failure risk
- Perioperative mortality (low but present)
- **Hospitalization required**
- Prolonged recovery

Goodman et al., 2016; Moskalenkoet al., 2023; Kirichenko et al., 2016;Pezzulla et al., 2024; Moon et al.,2018; Bae et al., 2023; Zheng et al.,2024; Romero et al., 2020;Andratschke et al., 2015

Moskalenko et al., 2023; Shi et al.,2022; Chen et al., 2016

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Comparative Effectiveness Summary

Parameter	SBRT	Surgery	RFA
Local Control	High (80-95%)	Highest (>90%)	High (similar for <2cm)
Severe Toxicity	Low (3-9%)	Higher (15-30%)	Low (5-10%)
Recovery	Minimal	Weeks-months	Days
Tumor Size	Any size	Any size	Best <3 cm
Invasiveness	None	High	Minimal

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Clinical Decision Algorithm

Liver Tumor Diagnosis

↓

Resectable + Good Candidate
→ **SURGERY** (Gold Standard)

Unresectable or High Risk
→ Consider alternatives ↓

Tumor <3 cm, accessible
→ **RFA or SBRT** (Similar efficacy)

Tumor ≥3 cm, near vessels, or multiple lesions
→ **SBRT PREFERRED**

Poor liver function (Child-Pugh C)
→ **Systemic therapy** or palliative care

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Take Home Message

- **Effectiveness:** Provides high local control and survival rates comparable to traditional local therapies
- **Safety:** Significantly lower toxicity profile than surgery, with minimal impact on quality of life
- **Versatility:** Effective for HCC, liver metastases, and as bridge to transplantation
- **Patient-Centered:** Noninvasive option for patients unsuitable for surgery or ablation

SBRT represents an essential tool in the multidisciplinary management of liver malignancies, expanding treatment options for patients previously considered inoperable

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