Stereotactic Body Radiation Therapy Versus Conventional External Beam Radiotherapy for Spinal Metastases: A Systematic Review and Meta-Analysis

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OBJECTIVE

Spinal metastases occur in up to 30% of patients with solid tumors and cause pain and neurological compromise. cEBRT remains the standard of care; SBRT delivers ablative doses with spinal cord sparing, but trials have not consistently shown SBRT to be superior.

Aim: to compare SBRT with cEBRT for complete pain response, local progression and overall survival in spinal metastases, with sensitivity and subgroup analyses and GRADE certainty.

4
randomized trials

570
patients, 3-month analysis

2.23
RR, complete pain response at 3 mo

0.93
HR, overall survival

METHODS

Design: PRISMA 2020 systematic review and meta-analysis; PROSPERO CRD420261364448.

- **Search:** PubMed and Embase from inception to 15 April 2026 (MeSH/Emtree and keywords).
- **Eligibility:** RCTs in adults (≥18 y) with spinal metastases comparing SBRT/SABR with cEBRT.
- **Data and bias:** two reviewers extracted data independently; Cochrane RoB 2.0.
- **Outcomes:** primary – overall and complete pain response (3 and 6 mo); secondary – local progression, overall survival, vertebral compression fracture (VCF).
- **Statistics:** random-effects (RevMan 5.4); RR/HR with 95% CI; I^2; leave-one-out sensitivity; subgroups by fractionation and trial size.
- **Certainty:** GRADE.

TABLE 1. PRISMA STUDY SELECTION

Stage	*n*
Records identified	97
Duplicates removed	7
Screened (title/abstract)	90
Full texts assessed	20
Excluded at full text	16
RCTs included	4

WHY TRIALS DIFFER

- **Ryu (RTOG 0631):** single fraction 16–18 Gy; stricter response (≥3-point vs ≥2-point improvement); target limited to the involved vertebra.
- **Sahgal:** 24 Gy in two fractions.
- **Guckenberger:** life expectancy >1 year; higher biologically effective doses.
- **Across trials:** pain tools (BPI, NRPS, VAS); SBRT 1–10 fractions; cEBRT 8 Gy/1 to 30 Gy/10.

TABLE 2. INCLUDED RCTS

Trial	*SBRT n**	*cEBRT n**
Sprave 2018	30	30
Sahgal 2021	114	115
Ryu 2023	138	76
Guckenberger 2024	36	31

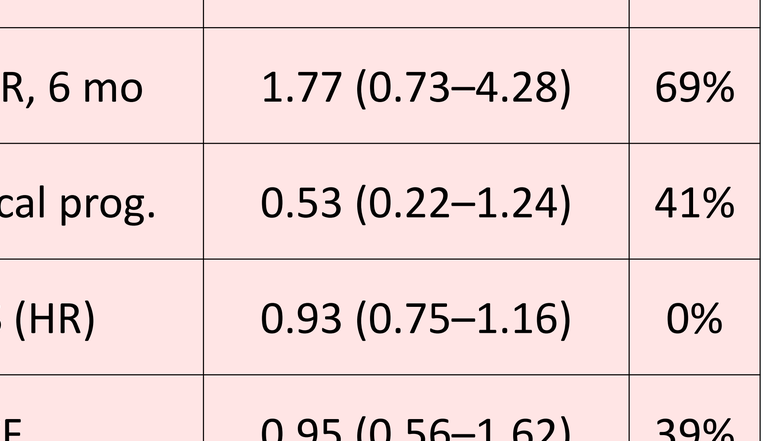
*Patients in the 3-month overall pain response analysis.

TABLE 3. POOLED OUTCOMES

Outcome	*RR / HR (95% CI)*	*I^2*
OPR, 3 mo	1.11 (0.73–1.68)	79%
OPR, 6 mo	1.34 (1.05–1.70)	20%
CPR, 3 mo	2.23 (1.46–3.41)	0%
CPR, 6 mo	1.77 (0.73–4.28)	69%
Local prog.	0.53 (0.22–1.24)	41%
OS (HR)	0.93 (0.75–1.16)	0%
VCF	0.95 (0.56–1.62)	39%

OPR/CPR = overall/complete pain response; OS = overall survival; VCF = vertebral compression fracture.

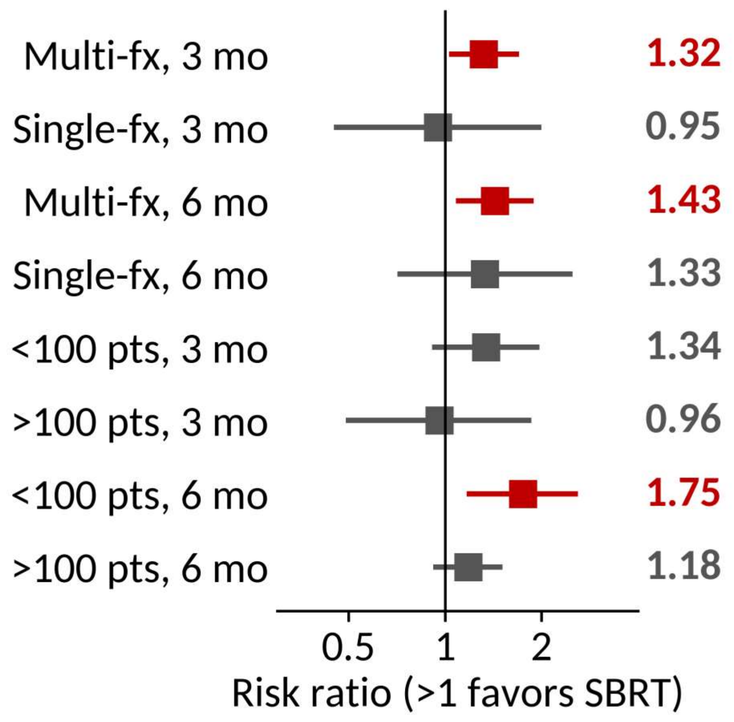
Fig 1: Pain response, SBRT vs cEBRT (RR, 95% CI; ◇ = leave-one-out)



RESULTS

- **Complete pain response at 3 mo:** RR 2.23 (1.46–3.41), I^2 0% – high certainty.
- **Overall pain response:** no difference at 3 mo (I^2 79%); better with SBRT at 6 mo – 50.2% vs 36.0% (RR 1.34).
- **No significant difference** in complete response at 6 mo, local progression, overall survival or VCF.
- **Leave-one-out:** excluding Ryu removed heterogeneity (I^2 79% → 0%) and favored SBRT; local progression RR 0.28 (0.09–0.83).
- **Multi-fraction SBRT** improved pain response at 3 and 6 mo; single-fraction did not (Fig 2).

Fig 2: Overall pain response by subgroup (RR, 95% CI)



CLINICAL IMPLICATIONS

- **Reasonable option:** stable spine (SINS <12), no neurological compromise, adequate performance status, life expectancy ≥3–6 months.
- **Life expectancy <3 months:** single-fraction 8 Gy cEBRT remains appropriate.
- **Mechanical pain** from instability: consider surgical stabilization.

CONCLUSION

SBRT is safe and effective for painful spinal metastases – superior complete pain response at 3 mo and overall pain response at 6 mo, without more VCF or myelopathy.

Heterogeneity across trials limits generalizability; individualize by prognosis, spinal stability and goals.

Limitations: only 4 open-label RCTs; differing pain definitions and instruments; no individual patient data.

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