

Salvage Surgery and Salvage Stereotactic Radiosurgery in Recurrent Skull Base Chordomas: A Meta-Analysis of Survival Outcomes

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Introduction

- Chordomas are rare, locally aggressive tumors originating from remnants of the notochord, with an incidence of approximately 0.08 per 100,000 persons according to recent Surveillance Epidemiology and End Results (SEER) registry data
- Skull base chordomas are rare, aggressive tumors with recurrence rates >50% at 10 years.
- Recurrent disease presents major treatment challenges due to prior surgery and radiation.
- Salvage surgery and stereotactic radiosurgery (SRS) are primary modalities.
- Comparative survival outcomes remain unclear.

Study Aim:

To evaluate pooled OS and PFS after salvage surgery and salvage SRS in recurrent skull base chordoma.

Results

Study Characteristics

- 490 recurrent patients across 12 studies
- 176 patients in pooled meta-analysis
- GTR achieved in 22%; STR in 73%

Pooled Overall Survival

- Surgery alone: Median 52.5 months; 5-year OS 47.2%
- Surgery + SRS: Median 36.6 months; 5-year OS 34.6%

Pooled Progression-Free Survival

- Surgery: Median 13.9 months; 5-year PFS 15%
- SRS: Median 16.6 months; 5-year PFS 16%

Methods and Materials

- PRISMA-guided systematic review
- Databases: PubMed, Embase, Web of Science
- Inclusion: Adult recurrent skull base chordoma, salvage surgery or SRS, KM survival data
- 12 studies included (490 patients)
- 4 studies (176 patients) eligible for pooled KM reconstruction
- Survival curves digitized (WebPlotDigitizer)
- Kaplan–Meier pooling performed in R (v4.4.2)
- Risk of bias: ROBINS-I & JBI (moderate risk)

Figure 1. PRISMA Flow Diagram of Included Studies

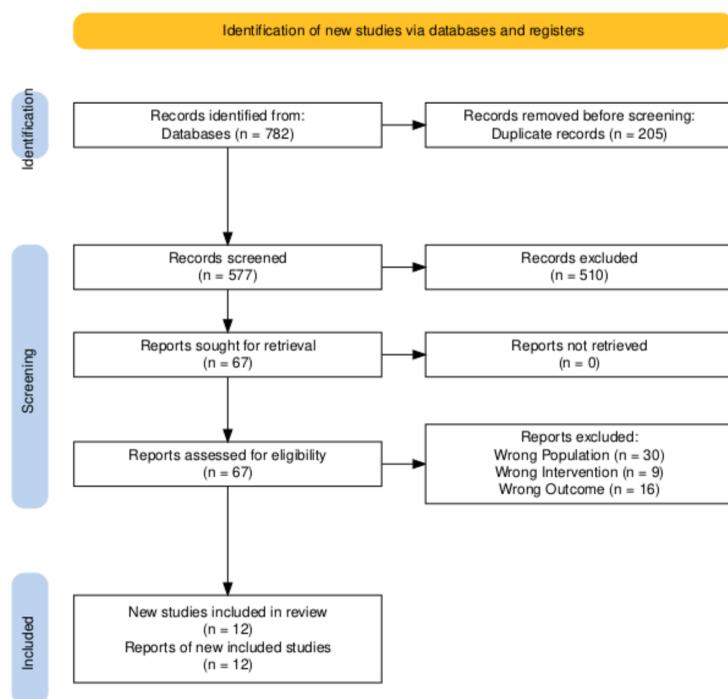


Table 1. Pooled Kaplan-Meier Survival Estimates

Group	Median (Months)	1 year (%)	2 year (%)	3 year (%)	4 year (%)	5 year (%)	6 year (%)	7 year (%)	8 year (%)
Surgery (OS)	52.54	81.7	74	62.4	54.1	47.2	45.4	43.4	40.6
Surgery & Radiation (OS)	36.58	75.9	58.6	53.9	42.2	34.6	29	22.6	22.6
Surgery (PFS)	13.88	56.9	30.1	15	15	15	7.5	7.5	7.5
Radiation (PFS)	16.62	68.2	34.2	21.4	16	16	16	16	10.7

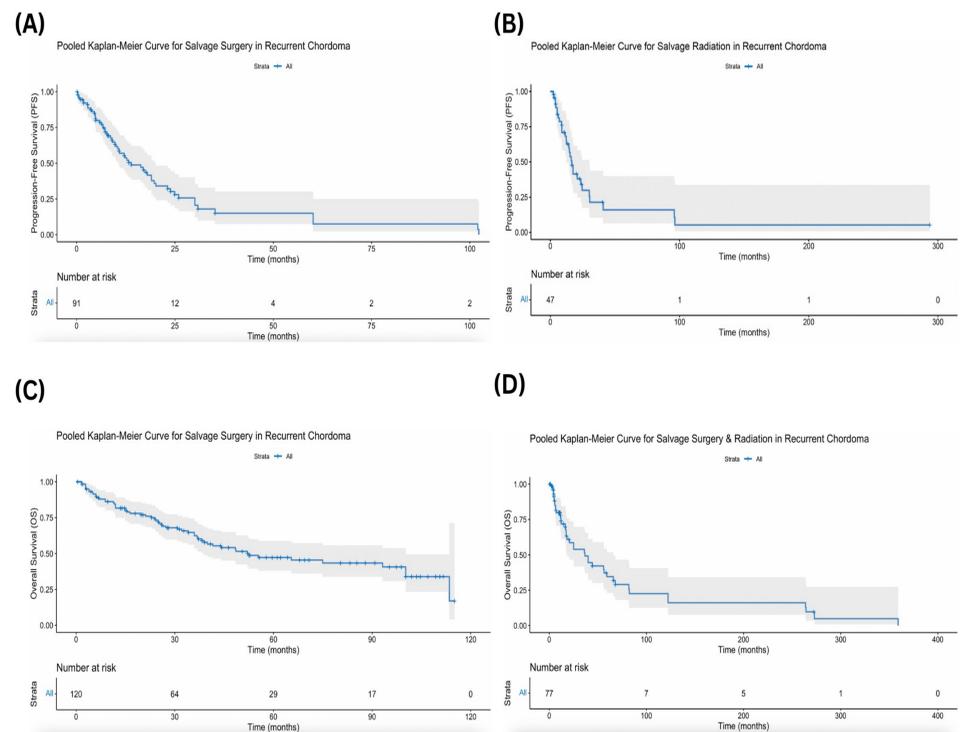


Figure 2. Pooled Kaplan–Meier survival analyses for recurrent chordomas. (A) Progression-free survival (PFS) following salvage surgery. (B) PFS following salvage SRS alone. (C) Overall survival (OS) after salvage surgery. (D) OS after salvage surgery combined with SRS. Shaded areas represent 95% confidence intervals.

Discussion

- Survival differences between salvage strategies likely reflect disease severity and prior treatment exposure rather than intrinsic treatment superiority.
- Prior radiation exposure and large tumor burden strongly limit achievable local control at recurrence.
- High rates of subtotal resection (73%) highlight anatomical constraints in the recurrent skull base setting.
- Progression-free survival is primarily driven by tumor biology and feasibility of complete cytoreduction.
- Outcomes in recurrent chordoma remain substantially worse than primary disease, emphasizing the prognostic impact of recurrence.

Conclusions

Salvage surgery and SRS provide limited long-term disease control in recurrent skull base chordoma. Surgery alone was associated with longer OS than surgery plus SRS, likely reflecting selection bias related to prior radiation exposure, tumor burden, and anatomical constraints. These findings highlight the need for individualized salvage strategies and recurrence-specific prospective studies to improve outcomes in this high-risk population.

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