



Comprehensive Outcomes Analysis of Stereotactic Radiosurgery and Stereotactic Radiotherapy for the Treatment of Meningioma

Lawrance K Chung BS; Ishani Mathur BS; Natalie E Barnette; Nolan Ung BS; Kimberly Thill BS; Daniel Tetsuji Nagasawa MD; Benjamin E Schmidt; Nicole Cremer BS; Brittany Voth BS; Isaac Yang MD
Department of Neurosurgery, University of California Los Angeles, Los Angeles, CA 90095



Introduction

Meningiomas are the most common extra-axial primary brain tumors and are typically treated with surgical resection. However, radiation therapy has emerged as an effective alternative in certain circumstances, yet the ideal conditions, restrictions, and outcomes of stereotactic radiosurgery (SRS) and fractionated stereotactic radiotherapy (FSRT) have remained ambiguous in the literature. The goal of this study is to determine the radiotherapy modality with the most improved clinical outcomes by comparing SRS or FSRT for the treatment of benign meningiomas and to provide an objective summary of their outcomes.

Methods

A PubMed literature review was performed and identified 3237 meningioma patients from 23 articles. Only studies that investigated benign meningioma (WHO grade I), with or without prior resection, were included. Treatment efficacies were analyzed. Studies that lacked adequate follow-up (<2 years) and clinical outcomes, or investigated other forms of radiation therapy were not considered.

Results

The average 5-year progression-free survival (PFS) for SRS was 93.4% (range: 85.0 – 100). The local control rates was from 84.0 – 98.3%, and the tumor regression rates was from 26.0 – 69.7%. The marginal dose delivered in SRS was from 12.0 – 17.7 Gy. The average 5-year PFS for FSRT was 94.8% (range: 90.0 – 98.1). The local control rates was from 86 – 100% and the tumor regression rates was from 14.0 – 48.3%. The marginal dose delivered in FSRT was from 48.4 – 57.6 Gy. **There is no significance difference in 5-year PFS between SRS and FSRT (p=0.46).**

Effect of Radiation Dose on Progression-Free Survival

392 patients from 3 SRS studies had a mean marginal dose <14 Gy, and 334 patients from 3 SRS studies had a mean marginal dose >=14 Gy. No difference in 5-year PFS rates was observed (91.6% vs. 93.5%, respectively, p-value=0.72).

260 patients from 2 FSRT studies had a mean marginal dose <54 Gy, and 235 patients from 2 FSRT studies had a mean marginal dose >=54 Gy. No difference in 5-year PFS rates was observed (93.9% vs. 95.4%, respectively, p-value=0.48).

Effect of Age on Progression-Free Survival

226 patients from 4 SRS studies had a mean age <58 years, and 231 patients from 3 SRS studies had a mean age >=58 years. No difference in 5-year PFS was observed (90.4% compared with 97.3%, p-value=0.09).

Table 1: Summary of SRS Studies

Study and Year	Patients (n)	Mean/Median Age (years)	Median Follow-up (months)	Mean/Median Marginal Dose (Gy)	5-year Progression-Free Survival (%)	Local Control Rate (%)	Tumor Regression Rate (%)
Bledsoe 2010	116	60*	70.1	15.1*	NA	92 (7 yr)	NA
Correa 2014	32	55	73.0	14.0	100 ¹	NA	48.3
DiBiase 2004	137	57	54.0	14.0	86.2	91.7	28.1
Eustacchio 2002	121	56	88.7	13.0	NA	98.3	60.3
Han 2008	63	50*	77.0	12.6*	90.2	90.4 (5 yr)	44.4
Kollova 2007	368	57	60.0	12.6	97.9	NA	69.7
Kreil 2005	200	57	94.8	12.0	98.5	97.5	57.0
Lee 2002	83	59*	36.0	13.0	93.1	96.9 (5 yr)	34.0
Metellus 2005	36	51*	63.6	15.0	94.4	94.4	52.7
Nicolato 2002	156	56*	48.9	14.6*	96.5	97.5	61.5
Pollock 2003	62	58*	64.0	17.7*	85.0	NA	NA
Starke 2012	255	55	78.0	14.0*	96.0	86	49.0
Starke 2015	75	55	78.0*	13.5*	88.6	84	35.0
Torres 2003	63	57*	40.6	15.7*	NA	92	35.0
Zada 2010	116	58	75.0	15.7*	98.9	94.1	26.0

*Mean ¹Reported value is for 5-year disease free survival

Table 2: Summary of FSRT studies

Study and Year	Patients (n)	Mean/Median Age (years)	Median Follow-up (months)	Mean/Median Marginal Dose (Gy)	5-year Progression-Free Survival (%)	Local Control Rate (%)	Tumor Regression Rate (%)
Correa 2014	57	56	73.0	50.4	98.1	93.1 (10 yr)	48.3
Debus 2001	189	53	35.0	56.8*	97.0	94.0 (5 yr)	14.0
Henzel 2006	224	56*	36.0	55.8	96.9	96.9	45.7
Kaul 2014	136	57	44.9	57.0*	93.8	95.6	19.0
Metellus 2005	38	53*	88.6	53.0	94.7	97.4	NA
Milker-Zabel 2005	317	56	68.0	57.6	90.0	93.1	23.0
Minniti 2009	27	NA	NA	50.0	100 ¹	100.0 (2 yr)	29.0
Selch 2004	45	59*	36.0	50.4	94.4 ²	98.0	18.0
Solda 2013	222	52	43.0	52.0*	93.0	86.0 (10 yr)	NA
Tanzler 2011	146	52	87.6	52.7	96.0 ³	96.0 (10 yr)	NA
Torres 2003	72	57*	24.0	48.4*	NA	97.2	32.0

*Mean ¹Reported value is for 2-year progression free survival ²Reported value is for 3-year progression free survival

³Reported value is for 5-year cause specific survival

Conclusions

Both SRS and FSRT show comparable high rates of survival and tumor control for the treatment of benign intracranial meningiomas.

According to current data, SRS and FSRT may both be effective radiation modalities when used appropriately. The choice of stereotactic technique should therefore be based on the limitations of each technique rather than on outcomes alone. Consideration for each patient’s tumor location and size will help determine the treatment modality that yields the longest PFS with the least complications.

References

- Whittle IR, Smith C, Navoo P, Collie D. Meningiomas. Lancet 2004;363:1535-43
- Fathi A, Roelche U. Meningioma. Curr Neurol Neurosci Rep 2013;13:337
- Maclean J, Fersht N, Short S. Controversies in Radiotherapy for Meningioma. Clinical Oncology 2014;26:51-64