Petroclival meningioma radiosurgery

- Face the Pain: Radiobiological and Clinical Considerations of Re-radiosurgery to the Trigeminal Nerve Following Irradiation of an Abutting Petroclival Meningioma
- Efficacy and safety of stereotactic radiosurgery for petroclival meningiomas: A systematic review and Meta-Analysis
- Surgical Strategy for Petroclival Meningioma-Related Trigeminal Neuralgia: The Role of Porus Trigeminus Opening
- Anterior transpetrosal approach and the tumor removal rate, postoperative neurological changes, and complications: experience in 274 cases over 33 years
- Treatment of Trigeminal Neuralgia Secondary to Petroclival Meningioma Using Microsurgical Resection, Microvascular Decompression, and Stereotactic Radiosurgery: 2-Dimensional Operative Video
- Comparison of the efficacy in improving trigeminal neuralgia in petroclival meningioma between microsurgery and radiosurgery: a meta-analysis
- Treatment Strategies and Current Results of Petroclival Meningiomas
- Trigeminal neuralgia pain outcomes following microsurgical resection versus stereotactic radiosurgery for petroclival meningiomas: a systematic review and meta-analysis

Systematic review

A meta-analysis calculated the pooled estimates for local tumor control (LTC), progression-free survival (PFS), and adverse radiation effect (ARE).

A total of 10 studies involving 605 patients were included. The meta-analysis revealed a pooled LTC rate of 94% (95% CI: 88-98%), a 5-year PFS rate of 94% (95% CI: 81-100%), and a 10-year PFS rate of 87% (95% CI: 69-98%). The meta-analysis for the SRS indication demonstrated that both primary and adjuvant SRS were associated with substantial LTC rates, and the difference was not significant (Primary: 95% [95% CI: 83-100%] vs. Adjuvant: 92% [95% CI: 69-100%], P = 0.65). The meta-analysis for the ARE indicated a pooled rate of 5% (95% CI: 0-12%).

The findings suggest that primary and adjuvant SRS are associated with significant LTC and PFS rates, along with minimal complications. Primary SRS may be considered for individuals with small or asymptomatic lesions, while adjuvant SRS is advised for larger or recurrent lesions [1)].

The meta-analysis consolidates data from 10 studies and 605 patients, providing pooled estimates for:

Local Tumor Control (LTC)

Progression-Free Survival (PFS)

Adverse Radiation Effects (ARE)

The pooled LTC rate of 94% and PFS rates at 5 and 10 years (94% and 87%) are impressive, suggesting strong long-term control. The ARE rate of 5% also supports the safety of stereotactic radiosurgery (SRS), whether used as primary or adjuvant treatment.

2. Methodological Limitations Despite the promising outcomes, several limitations and potential biases undermine the strength of the conclusions:

Sample Size and Study Heterogeneity: Only 10 studies with 605 patients were included. Given the wide confidence intervals (e.g., Adjuvant LTC: 69–100%), the estimates show substantial variability, which may reflect differences in:

tumor types

lesion sizes

imaging follow-up duration

radiation dose/fractionation

Selection Bias: Many retrospective studies may have been included, with non-randomized treatment allocation (e.g., primary SRS for smaller lesions, adjuvant for larger/recurrent), which confounds the outcome comparison between groups.

Publication Bias Not Addressed: There’s no mention of publication bias assessment (e.g., funnel plots, Egger’s test). The absence of negative or neutral studies could skew pooled estimates upward.

ARE Rate Possibly Underestimated: The 5% ARE rate seems low considering the known risks of radionecrosis or perilesional edema, especially in larger lesions or previously irradiated fields. Without standardized radiological criteria or prospective neuroimaging review, ARE may be underreported.

3. Statistical Interpretation The non-significant difference in LTC between primary and adjuvant SRS ($P = 0.65$) is not evidence of equivalence. It may reflect insufficient statistical power, particularly due to small sample sizes in subgroups and overlapping confidence intervals.

The very high 5-year PFS (94%) approaching LTC (94%) may suggest misclassification or limited follow-up in some studies. True PFS should account for both local and distant progression, which is not clarified.

4. Clinical Implications and Cautions The recommendation to use primary SRS for small/asymptomatic lesions is reasonable but must be balanced against tumor biology, risk of transformation, and the potential for missed diagnosis (especially in radiologically ambiguous lesions).

The suggestion that adjuvant SRS be reserved for larger or recurrent lesions follows standard practice but may ignore the nuances of multimodal planning (e.g., surgery + SRS vs. upfront SRS).

5. Conclusion While this meta-analysis provides encouraging pooled outcomes, the interpretation should remain cautious due to:

limited and heterogeneous data

Possible underreporting of complications

lack of control for confounders

Future prospective, controlled studies with standardized definitions, imaging criteria, and longer follow-up are needed to definitively position primary vs. adjuvant SRS in clinical decision-making.

Wijaya et al. constructed a systematic review using the PRISMA guidelines using peer-reviewed English literature until 16 February 2022 from Europe PubMed Central and PubMed. We used the terms petroclival meningioma, clival meningioma, apex petrous meningioma, spheno petroclival meningioma, stereotactic radiosurgery, radiosurgery, CyberKnife, Gamma Knife, linear accelerator, LINAC, and radiotherapy.

10 out of 266 studies were chosen for this systematic review, two of which are case reports. The study comprised 719 patients, 73.7% of whom were female (n = 530) and had a median age of 56.99 years (18-90 years). At the time of diagnosis, the median tumor volume was 6.07 cm3 (0.13-64.9 cm3). The tumors were frequently located near the petroclival junction (83.6%, n = 598). Following SRS, the median follow-up was 64.52 months (3-252 months). 46.5% of 719 PMs exhibited a decrease in tumor size. 46% and 7.5% showed no change and increase in tumor volume, respectively. At the last radiographic follow-up (7-21.2 years), tumor control with a median of 98.8% (85-100%). Complications occurred in 6% of patients, with hydrocephalus (2.2%) as the prevalent complication. The use of SRS as a primary treatment for petroclival cases was not associated with increased complication rate RR 0.62 (95% CI [0.11, 3.59], p = 0.59) but statistically correlated with clinical failure clinical failure RR 0.56 (95% CI [0.32, 0.98], p = 0.04).

They found a low number of complications following SRS intervention and has been effectively controlling tumor progression [2].

Complications

Although SRS continues to gain favor as a treatment modality, delayed malignant degeneration is a potential complication and physicians should counsel patients of this risk [3].

Case series

GKRS can be considered an effective and safe treatment for large-volume petroclival meningiomas. However, for patients with large size or multiple masses, the treatment method should be determined with caution because the probability of complications after GKRS may increase [4].

Stereotactic radiosurgery is an obvious alternative for primary treatment of these tumours. There are not very many reports a fact that reflects concerns regarding tolerance in view of the vicinity of the brainstem. The Pittsburgh group reported their experience in a series of 39 patients with a median follow-up period of 37 months. Neurological status improved in 21 %, remained stable in 66 %, and eventually worsened in 13 %. Tumour volumes decreased in 23 %, remained stable in 68 % and increased in 8 % [5].

A multicenter study of 254 patients with a benign petroclival meningioma was conducted through the North American Gamma Knife Consortium. One hundred and forty patients were treated with upfront

radiosurgery, and 114 following surgery. Multivariate analysis was used to determine predictors of favorable defined as no tumor progression following radiosurgery and the absence of any new or worsening neurological function. At mean follow up of 71 months (range 6-252), tumor volumes increased in 9 % of tumors, remained stable in 52 %, and decreased in 39 %. Kaplan-Meier actuarial progression free survival rates at 3, 5, 8, 10, and 12 years were 97, 93, 87, 84, and 80 % respectively. At last clinical follow-up, 93.6 % of patients demonstrated no change or improvement in their neurological condition whereas 6.4 % of patients experienced progression of symptoms. Favorable outcome was achieved in 87 % of patients and multivariate predictors of favorable outcome included smaller tumor volume (OR = 0.92; 95 % CI 0.87-0.97, p = 0.003), female gender (OR 0.37; 95 % CI 0.15-0.89, p = 0.027), no prior radiotherapy (OR 0.03; 95 % CI 0.01-0.36, p = 0.006), and decreasing maximal dose (OR 0.92; 95 % CI 0.96-0.98, p = 0.010). GKRS of petroclival meningiomas achieves neurological preservation in most patients and with a high rate of tumor control [6].

References

1)

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