Research

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Radiotherapy as a Primary Treatment for Olfactory Groove Meningiomas: Preservation of Cranial Nerve Function and Maintenance of Quality of Life

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1. Abstract

1.1. Objective: Olfactory groove meningiomas (OGMs) are uncommon tumors, and therefore limited information exists regarding the use of radiotherapy (RT), including fractionated stereotactic radiotherapy (FSRT) and stereotactic radiosurgery (SRS), as a primary treatment. This study evaluates treatment effectiveness, toxicity, cranial nerve (CN) outcomes, and quality of life (QOL) in patients with OGMs treated primarily with RT.

1.2. Methods: Seven patients who underwent primary treatment with FSRT or SRS were retrospectively reviewed. Clinical follow-up included neurological examinations and magnetic resonance imaging (MRI). Quality of life and sinonasal symptoms were evaluated using the Sino-Nasal Outcome Test (SNOT-20).

1.3. Results: After a median follow-up period of 64 months (range 21–125 months), local tumor control was achieved in all patients. Overall survival was 86%, while cause-specific survival related to the tumor was 100%. At diagnosis, several patients experienced symptoms such as reduced or absent sense of smell, visual impairment, facial pain, and tinnitus. Following radiotherapy, some patients experienced recovery of olfactory function, improvement in vision, reduction in facial pain, and resolution of tinnitus. Imaging demonstrated either reduction in tumor size or stability in all cases. Headaches that were present before treatment resolved in affected patients. Quality of life assessments showed excellent scores both before treatment and during follow-up.

1.4. Conclusion: Primary radiotherapy for OGMs demonstrated excellent tumor control with preservation or improvement of cranial nerve function and sustained quality of life. These findings suggest that RT may represent a safe and effective treatment option for selected patients with OGMs. Further prospective research is required to better define its role in multidisciplinary management.

2. Keywords: Olfactory groove meningioma; Radiotherapy; Cranial nerve function; Quality of life; Stereotactic radiosurgery

3. Introduction

Olfactory groove meningiomas are slow-growing tumors arising from the anterior cranial base and represent approximately 10% of all intracranial meningiomas. Management options include observation, surgical resection, and radiotherapy. Radiotherapy may be delivered as stereotactic radiosurgery or fractionated stereotactic radiotherapy.

Surgical removal has traditionally been considered the primary treatment because it can achieve high tumor control rates and very low perioperative mortality. However, surgery also presents several limitations. Complete tumor removal may be difficult when the tumor involves important neurovascular structures or extends laterally beyond anatomical boundaries that are difficult to access through endoscopic approaches. In addition, surgical resection almost always results in loss of olfactory nerve function. Other potential complications include cerebrospinal fluid leakage, postoperative seizures, frontal lobe swelling, and damage to additional cranial nerves. Tumor recurrence has also been reported several years after surgery.

Radiotherapy is typically reserved for tumors located in regions where surgery carries significant risk, such as the optic nerve sheath, cavernous sinus, skull base, or internal auditory canal. It may also be considered when tumors are not surgically resectable or when patients are not suitable candidates for surgery due to medical comorbidities.

Recent investigations have demonstrated that both stereotactic radiosurgery and fractionated stereotactic radiotherapy can achieve tumor control rates comparable to surgery while minimizing treatment-related complications. In addition, radiotherapy has been shown to preserve or even improve cranial nerve function in certain types of meningiomas. Despite these findings, limited data exist regarding its use specifically for olfactory groove meningiomas.

The present study evaluates the outcomes of primary radiotherapy

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in patients with OGMs, focusing on tumor control, cranial nerve preservation, and patient quality of life.

4. Methods

After obtaining institutional review board approval, medical records of seven patients diagnosed with symptomatic olfactory groove meningiomas and treated with primary radiotherapy between 1994 and 2011 were retrospectively reviewed. Information was collected from hospital records, MRI scans, radiotherapy treatment plans, and follow-up visits conducted by neurosurgery and radiation oncology teams.

Diagnosis was confirmed either through surgical pathology or through characteristic radiological findings on contrast-enhanced T1-weighted MRI scans.

5. Radiotherapy Treatment

All cases were discussed in a multidisciplinary tumor board including neurosurgeons, radiation oncologists, and neuroradiologists. Treatment decisions regarding the use of stereotactic radiosurgery or fractionated stereotactic radiotherapy were made after considering tumor size, symptom severity, cranial nerve function, overall patient condition, and patient preferences.

Patients with larger tumors or intact cranial nerve function were generally recommended fractionated stereotactic radiotherapy. However, some patients opted for stereotactic radiosurgery due to the convenience of a single treatment session.

Earlier patients receiving FSRT were treated using a linear accelerator system with stereotactic immobilization frames and specialized planning software. Later patients were treated using more advanced stereotactic systems that incorporated mask-based immobilization and image-guided localization techniques.

Fractionated stereotactic radiotherapy was delivered using conventional fractionation schedules designed to reduce the risk of radiation injury to nearby structures such as the optic nerves and optic chiasm. Highly conformal radiation delivery was achieved using multiple beam arrangements.

Patients treated with stereotactic radiosurgery received treatment using Gamma Knife systems.

6. Follow-Up and Evaluation

Patients were initially evaluated three months after treatment and subsequently followed annually for up to ten years. Follow-up evaluations included neurological examinations and MRI scans.

Tumor control was defined as either stabilization or reduction in tumor size on imaging studies.

Treatment-related toxicity was defined as complications occurring within three months after radiosurgery or within three months from the start of fractionated radiotherapy.

Cranial nerve function was evaluated before treatment and during follow-up visits. Olfactory function was assessed based on patient-reported changes, while visual symptoms were assessed through ophthalmologic evaluation when necessary.

Quality of life was measured using the Sino-Nasal Outcome Test (SNOT-20), a validated questionnaire consisting of twenty items rated on a scale from 0 to 5. These questions assess symptoms across four domains: rhinological symptoms, ear and facial symptoms, sleep disturbances, and psychological wellbeing.

7. Results

Seven patients were included in the study, consisting of four women and three men. The median age was 57 years. Most patients sought treatment due to symptoms such as reduced sense of smell, headaches, or visual disturbances.

Tumor sizes varied, with a median diameter slightly above three centimeters. Most patients received fractionated stereotactic radiotherapy with total doses ranging approximately between 50 and 56 Gy delivered in small daily fractions. A smaller number of patients received single-fraction stereotactic radiosurgery.

After a median follow-up period of more than five years, all tumors remained controlled. One patient died during follow-up due to unrelated medical conditions, resulting in an overall survival rate of 86%. None of the deaths were related to the tumor.

Radiological evaluation showed tumor shrinkage in some patients and stable disease in the remainder. No cases demonstrated tumor progression.

Before treatment, several patients experienced cranial nerve-related symptoms such as decreased or absent sense of smell, visual disturbances, facial pain, or tinnitus. Following radiotherapy, improvements were observed in several patients. Some individuals regained partial olfactory function, while others experienced better visual function or reduced facial pain. Tinnitus resolved in affected individuals.

Importantly, no patients experienced worsening of cranial nerve function following treatment. Lower cranial nerves remained intact throughout the observation period. Headaches present at the time of diagnosis resolved after treatment.

Two patients developed temporary peritumoral brain edema shortly after treatment, which resolved with medical management. No chronic treatment-related toxicities were observed.

Quality of life assessments demonstrated that patients maintained excellent overall wellbeing both before treatment and during long-term follow-up.

8. Discussion

This study examined the effectiveness and safety of primary radiotherapy in patients with olfactory groove meningiomas. The results demonstrate that radiotherapy can achieve excellent tumor control while preserving neurological function.

Historically, surgery has been the standard treatment for meningiomas, including those located in the olfactory groove.

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However, surgical resection frequently results in permanent loss of olfactory function. In contrast, radiotherapy offers a non-invasive alternative that may preserve or even restore cranial nerve function.

The outcomes observed in this study are consistent with previous research showing high tumor control rates for stereotactic radiosurgery and fractionated radiotherapy in meningiomas located near sensitive structures. Radiotherapy is particularly valuable when surgery carries higher risks due to tumor location or patient comorbidities.

Both radiosurgery and fractionated radiotherapy appeared to provide similar outcomes in terms of tumor control and neurological preservation. Fractionated treatment may offer additional safety when tumors are located close to the optic apparatus, as smaller daily doses reduce the risk of radiation-induced optic nerve damage.

The findings also highlight the possibility of functional recovery following radiotherapy. Several patients experienced improvements in olfactory or visual function after treatment. Such improvements may occur when radiation reduces tumor compression on adjacent cranial nerves.

Another important aspect of this study is the evaluation of quality of life. Using a validated questionnaire, patients reported good overall wellbeing, with minimal symptoms related to nasal, ear, sleep, or psychological domains. This suggests that radiotherapy not only controls tumor growth but also preserves patient quality of life.

However, this study has several limitations. The analysis was retrospective and involved a small number of patients. Additionally, quality of life questionnaires were completed near the end of follow-up, which may introduce recall bias.

Future research should focus on identifying patient subgroups that may benefit most from radiotherapy. For instance, patients with smaller tumors and minimal symptoms may be suitable candidates for primary radiotherapy, while larger tumors producing significant mass effect may still require surgical resection followed by adjuvant radiotherapy.

Advances in molecular biology may also improve treatment selection. Genetic alterations such as mutations affecting chromosome 22 and the NF2 gene are known to contribute to meningioma development. Other pathways involving tumor suppressor genes, oncogenes, and signaling pathways may also influence tumor behavior and treatment response. Understanding these mechanisms may help personalize therapy in the future.

9. Conclusion

Primary radiotherapy for olfactory groove meningiomas demonstrated excellent long-term tumor control, preservation or improvement of cranial nerve function, and maintenance of high quality of life. These findings suggest that radiotherapy may serve as an effective primary treatment option for carefully selected patients with OGMs. Larger prospective studies are required to confirm these results and further define the role of radiotherapy in the management of these tumors.

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