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Case report

Multifocal meningiomatosis: A case study highlighting diagnostic and monitoring challenges

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Abstract. This case presentation discusses the diagnostic and monitoring challenges of a rare case of multifocal meningiomatosis in a 27-year-old female who initially presented with dizziness, migraine and facial hemiparesis in 2019. Emergency CT revealed multiple formations with calcifications of extra-axial origin. Subsequent contrast-enhanced MRI exposed approximately 20 meningiomas in both cerebral and medullary locations. A comparison of MRI findings from 2019 to 2023 demonstrated an average growth of meningiomas from 3 to 5 mm. This case report emphasizes the crucial role of contrast-enhanced MRI in the diagnosis and monitoring of meningiomatosis, underscores the complexity of managing meningiomatosis and shows the importance of close clinical and radiological follow-up in determining the appropriate timing for intervention (www.actabiomedica.it).

Key words: meningioma, MRI, neuroradiology, CT, tumor, neuro-oncology

Introduction

Meningiomas are the most common primary brain tumors in adults, typically manifesting as solitary lesions (1). However, meningiomatosis, characterized by the presence of multiple meningiomas scattered throughout the central nervous system, is a rare and challenging clinical entity. It poses unique diagnostic and therapeutic dilemmas, particularly when encountered in young adults. The diagnosis of meningiomatosis usually involves a combination of medical imaging techniques such as magnetic resonance imaging (MRI) or computed tomography (CT) scans, which can help visualize the location, size and number of meningiomas. A biopsy may also be performed to confirm the diagnosis and determine whether the tumors are benign or malignant. Meningiomatosis presents significant challenges in diagnosis and management, particularly due to its rarity and diverse clinical presentation. This case report contributes to the existing literature by highlighting a rare case of multifocal meningiomatosis and discussing the diagnostic and monitoring challenges encountered in its management. By sharing this case with the medical community, we aim to provide insights into the diagnostic approach, monitoring strategies, and therapeutic considerations for multifocal meningiomatosis.

Case Presentation

A 27-year-old female presented in 2019 with dizziness, migraine and facial hemiparesis in our Emergency department. The patient reported a history of intermittent headaches over the past year, which she attributed to stress. However, over the preceding month, she noticed a gradual onset of dizziness, particularly upon standing up or changing positions. Additionally,

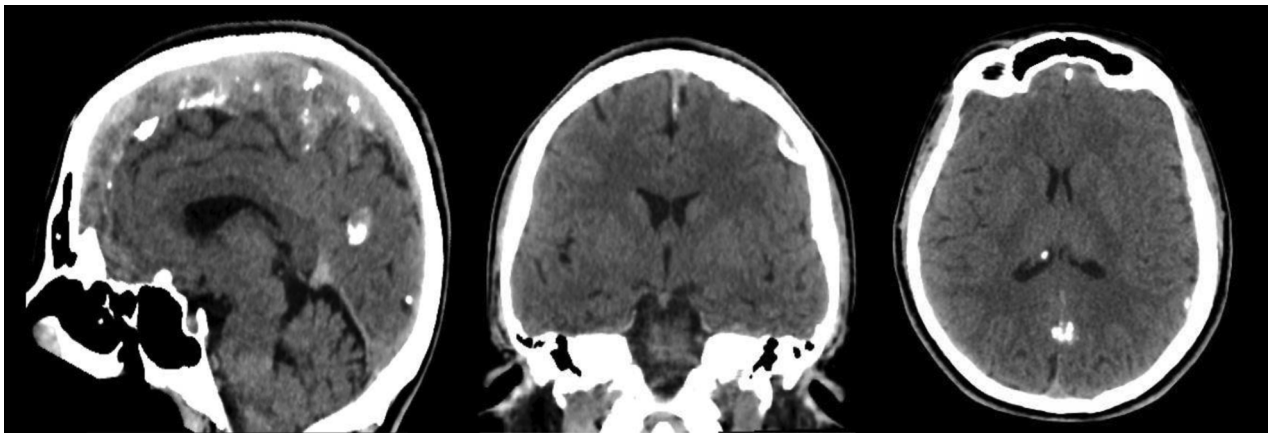

Figure 1. The basal CT scan showed several solid, well-defined, and extra-axial masses involving the mid falx cerebri, which are spontaneously hyperdense, with some minor peripheral calcifications foci.

she experienced episodes of weakness on the left side of her face, accompanied by mild numbness and tingling. There was no history of trauma or recent illness. Family history was unremarkable for neurological disorders or malignancies. The patient's past medical history was significant for mild asthma, which was well-controlled with as-needed bronchodilators. Upon examination, the patient appeared alert and oriented to person, place and time. Vital signs were within normal limits. Cranial nerve examination revealed decreased sensation to light touch on the left side of the face, corresponding to the distribution of the trigeminal nerve. Motor strength was preserved in the upper and lower extremities, with no focal weakness appreciated. Deep tendon reflexes were symmetrically brisk, and plantar responses were flexor bilaterally. There were no signs of meningeal irritation. Fundoscopic examination was unremarkable, with no papilledema noted. Blood tests conducted alongside clinical examination revealed no systemic pathology underlying the patient's neurological symptoms, indicating overall good health status. These symptoms prompted a thorough clinical evaluation, including neuroimaging studies to identify potential underlying causes. A high-resolution non-contrast CT scan was performed using a multidetector scanner (GE Optima 128-slice CT), revealing multiple extra-axial formations with discernible calcifications. This initial imaging played a crucial role in identifying the presence and calcific nature of the lesions, prompting further investigation. The emergency CT protocol included axial slices with a slice thickness of 1 mm and reconstruction at 0.5 mm intervals (Figure 1).

Subsequent to the CT findings, a comprehensive MRI protocol was implemented for detailed characterization. A 3-Tesla MRI scanner (Siemens Magneton Vida 3T MRI) was utilized for optimal resolution. The protocol included T1-weighted, T2-weighted, fluid-attenuated inversion recovery (FLAIR) and susceptibility-weighted imaging (SWI) sequences for anatomical delineation and lesion characterization. To highlight the meningiomas, a gadolinium-based contrast agent was administered for T1-weighted imaging. The contrast-enhanced MRI not only confirmed the presence of meningiomas but also provided essential information regarding their number, size and contrastographic impregnation. The MRI revealed around 20 meningiomas in both cerebral and medullary locations (Figure 2-3), with the most prominent one in the left frontal region measuring 12x10x10 mm (APxLLxCC). The patient underwent annual brain and medulla MRIs, and a comparison of MRI results from 2019 to 2023 indicated an average increase in meningiomas'

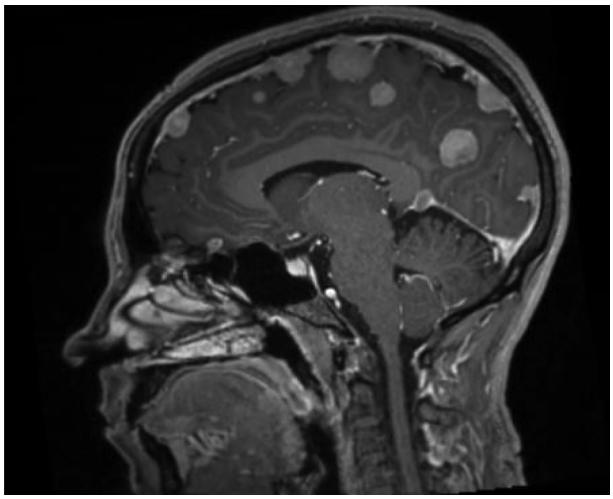

Figure 2. Sagittal T1 C+ (Gd) MRI showed multiple homogeneous and well-circumscribed extra-axial masses with a broad dural base and homogeneous enhancement along the great cerebral falx partially involving the superior sagittal sinus.

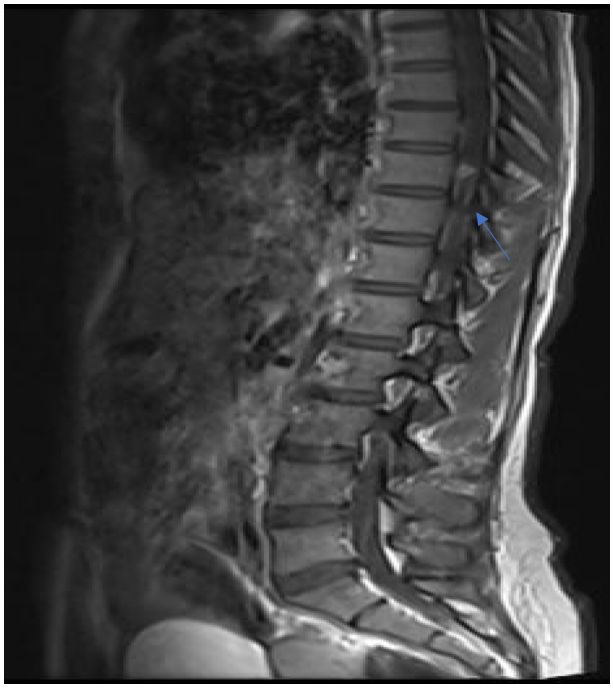

Figure 3. Sagittal T1 C+ (Gd) MRI of the toraco-lumbar spine showes the presence of a homogeneous and well-circumscribed extra-axial mass with homogeneous enhancement and broad dural base at T10 level.

size from 3 to 5 mm. The largest one in the left frontal region grew to 23x22x21 mm (Figure 4). Subsequent MRI scans adhered to the original protocol, ensuring consistent monitoring and accurate evaluation of meningioma growth over time. The genetic analyses have ruled out the presence of mutations, confirming that it is a case of sporadic meningioma. Upon confirmation of multifocal meningiomatosis based on imaging and blood test results, a multidisciplinary team consisting of neurosurgeons, neurologists and radiologists convened to devise an individualized treatment plan for the patient. Given the asymptomatic nature of the patient's meningiomas and absence of neurological deficits beyond mild facial hemiparesis, the decision was made to adopt a conservative management approach initially. The treatment plan focused on regular monitoring of the patient's neurological status through serial imaging studies and clinical assessments. The patient underwent annual brain and medulla MRIs to monitor the size, number and growth pattern of the meningiomas. Additionally, clinical follow-up appointments were scheduled to assess for any new neurological symptoms or changes in existing symptoms. Pharmacological therapy was initiated to manage the patient's occasional dizziness and migraine headaches, aiming to improve her quality of life and alleviate any associated discomfort.

Surgery wasn't necessary due to the lack of significant mass effect or neurological issues. Close monitoring was maintained to detect any symptom progression or tumor growth, potentially requiring treatment reevaluation. The patient was educated on her condition and the importance of regular monitoring. A patient-centered treatment plan prioritizing symptom management and neurological function preservation was devised to ensure ongoing care with minimal risks from aggressive interventions.

Discussion

The presented case of multifocal meningiomatosis underscores the rarity and complexity of this clinical

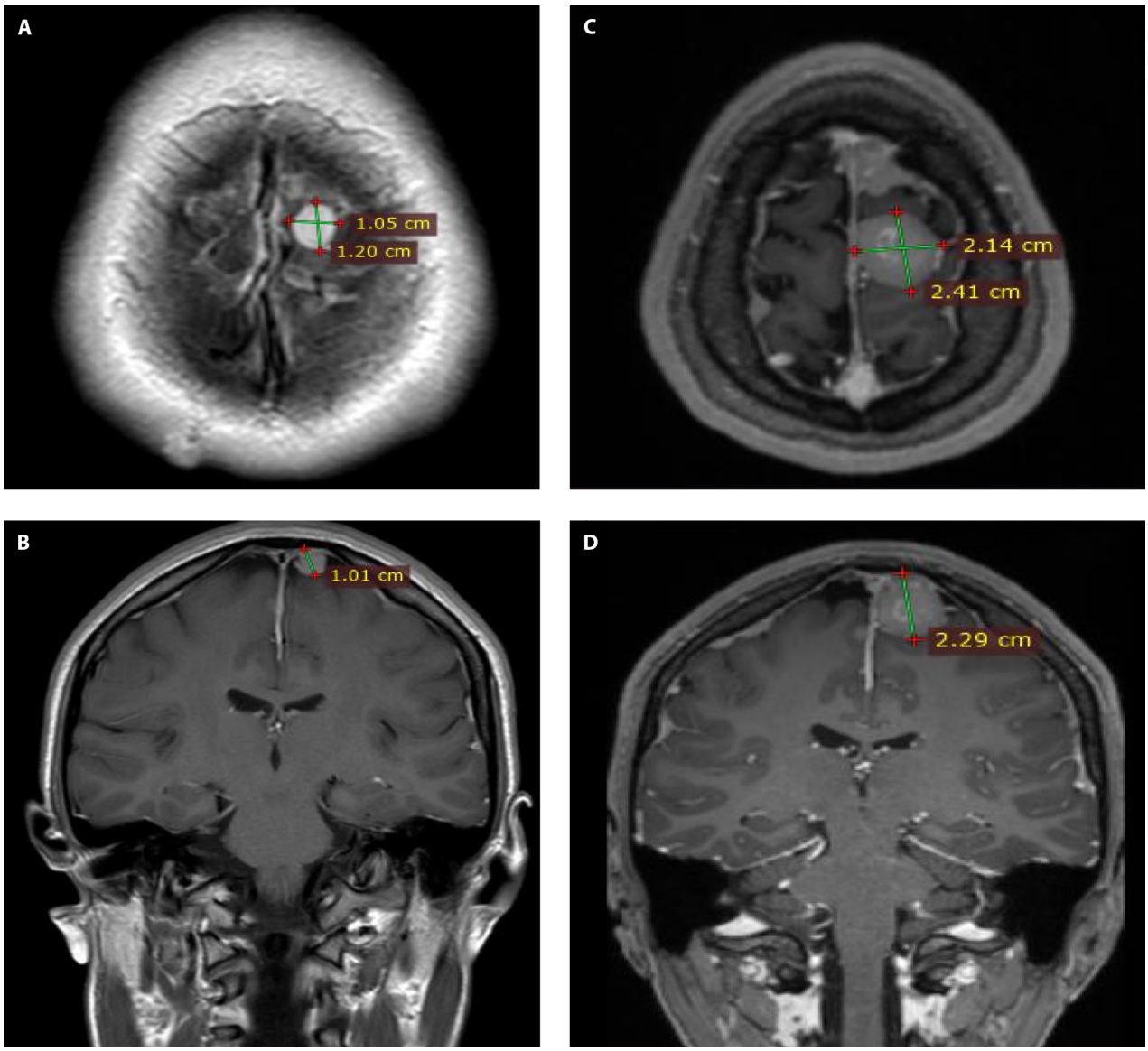

Figure 4. A comparison of axial and coronal T1 C+ (Gd) MRI scans from 2019 (A, B) to 2023 (C, D) indicated the enlargement of the most prominent meningioma located in the left frontal region, which measured measuring 12x10x10 (APxLLxCC) in the 2019 and 23x22x21 mm in the 2023.

entity, necessitating a thorough understanding of its diagnostic and management challenges. Meningiomas, while commonly encountered as solitary lesions, present unique diagnostic and therapeutic dilemmas when occurring in a multifocal pattern throughout the central nervous system (2). This case contributes to the existing literature by highlighting the diagnostic intricacies and longitudinal management strategies essential for optimizing patient outcomes in such cases.

Meningiomatosis is a rare variant of meningioma presentation characterized by the presence of multiple tumors in various locations within the central nervous system. Its etiology remains unclear, and its occurrence in young adults, as in our case, is particularly uncommon (3). Meningiomas are tumors that originate from the meninges, which are the protective membranes that cover the brain and spinal cord. These tumors are usually benign, but in meningiomatosis,

multiple meningiomas develop throughout the central nervous system, and they may be located in various regions such as the brain, spinal cord, and optic nerve (4). Existing literature suggests that multifocal meningiomatosis may be sporadic or associated with genetic syndromes such as neurofibromatosis type 2 (NF2) or familial multiple meningioma syndrome (5). While our case ruled out the presence of mutations associated with NF2, the etiology of sporadic multifocal meningiomatosis remains unclear, warranting further investigation into potential genetic and environmental factors contributing to its pathogenesis. NF2 is an inherited disorder characterized by the development of tumors in the nervous system, including meningiomas (6). The symptoms of meningiomatosis vary depending on the size and location of the meningiomas. Common symptoms may include headaches, seizures, visual disturbances, weakness or numbness in the limbs, difficulty with balance or coordination and changes in mental functioning. The severity and progression of symptoms can vary widely among affected individuals. The diagnosis of multifocal meningiomatosis typically involves a combination of advanced imaging techniques, such as magnetic resonance imaging (MRI) or computed tomography (CT) scans, and a biopsy may also be performed to confirm the diagnosis and determine whether the tumors are benign or malignant (7). Differential diagnosis often includes other central nervous system tumors, such as metastases or primary gliomas, underscoring the importance of meticulous radiological evaluation and histopathological confirmation in reaching an accurate diagnosis. CT imaging is useful in an emergency setting and provides initial information about the location, size, and density of meningiomas. It is particularly valuable in assessing bony involvement and detecting calcifications. CT angiography (CTA) aids in evaluating the vascular supply of meningiomas (8). MRI is the imaging modality of choice for evaluating meningiomatosis. Key MRI sequences, such as T1-weighted, T2-weighted, Susceptibility weighted imaging (SWI), post-contrast T1-weighted and diffusion-weighted imaging provide crucial information regarding tumor characteristics, such as size, shape, enhancement pattern, edema, and invasion into adjacent structures (9). Meningiomatosis exhibits a diverse range of imaging features, including multiple dural-based, intraventricular, or intraosseous meningiomas. Various imaging patterns, such as "salt-and-pepper," "snowball," "grape-like," and "beaded" appearances, may be observed. These patterns may reflect different stages of tumor growth and progression. Meningiomas typically enhance avidly with contrast, and their growth can be accurately tracked over time (10). Treatment options for meningiomatosis depend on various factors, including the size, location, and number of meningiomas, as well as the presence of symptoms. The management of multifocal meningiomatosis poses significant challenges due to the diverse locations and variable growth patterns of the meningiomas (11). While surgical resection remains the mainstay of treatment for symptomatic or accessible lesions, the management of asymptomatic or surgically inaccessible tumors requires a nuanced approach (12). Longitudinal monitoring through serial imaging studies, as demonstrated in this case, allows for the timely detection of tumor progression and the adjustment of management strategies accordingly. Treatment may involve surgical removal of the tumors, radiation therapy or a combination of both. Regular monitoring and follow-up are necessary to detect any recurrence or growth of the tumors (13). The presented case corroborates existing literature regarding the indolent nature of meningiomas, with slow but progressive growth over time (14). The absence of significant neurological deficits despite radiological evidence of tumor growth underscores the importance of individualized treatment plans tailored to the patient's clinical status and symptomatology (15). In our case, the decision to monitor the patient closely with serial imaging was made due to the extensive distribution of lesions and the potential risks associated with surgical resection (16). In the clinical management of meningiomas, it is imperative for clinicians to consider the differential growth rates observed among tumors of varying World Health Organization (WHO) grades. Recent studies have highlighted the heterogeneous nature of meningiomas, with WHO grade II and III tumors often demonstrating more aggressive growth patterns compared to WHO grade I tumors (17). Moreover, emerging evidence suggests that the molecular and genetic characteristics of meningiomas play a crucial role in tumor progression and response to treatment. For

instance, mutations in genes such as NF2, AKT1 and SMO have been associated with higher tumor grades and increased proliferation rates (18-19). Clinicians should therefore incorporate molecular profiling into their diagnostic and prognostic assessments to better stratify patients and tailor treatment strategies accordingly. Additionally, recent advancements in imaging techniques, such as advanced MRI sequences, such as DWI and PWI, and positron emission tomography (PET) scans, have enabled more accurate characterization of meningiomas and assessment of treatment response (20). These imaging modalities provide valuable insights into tumor biology, including vascularization, cellular density and metabolic activity, which can inform treatment decisions and prognosis. Recent data have underscored the importance of serial imaging in monitoring meningioma growth, with studies demonstrating that even small increases in tumor size (>10%) can be associated with the development of clinical symptoms (21). By closely monitoring tumor growth and response to treatment, clinicians can intervene promptly to mitigate the risk of symptom development and optimize patient outcomes (22). Integrating these recommendations into clinical practice can enhance the precision of treatment planning and improve overall outcomes for patients with meningiomas. Future studies exploring the role of genetic predisposition, molecular biomarkers and targeted therapies may offer new insights into personalized treatment approaches for this rare condition.

Conclusion

This case emphasizes the critical role of advanced imaging protocols, including emergency CT and longitudinal MRI, in the diagnostic and monitoring process of multifocal meningiomatosis and underscores the imperative for a nuanced, interdisciplinary approach in both clinical practice and medical education. The detailed imaging strategies employed provided essential information for accurate diagnosis, characterization and longitudinal assessment, guiding informed clinical decisions and treatment planning. For clinicians, it is essential to craft individualized treatment plans, taking into account the unique characteristics of each patient's condition. Moreover, patient education plays a crucial role in empowering individuals to actively participate in their care decisions and adhere to treatment regimens. For educators, utilizing cases such as this in medical education can foster critical thinking skills and interdisciplinary collaboration among students.

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Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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