Interesting Image

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Molecular Perspectives on Meningioma with Osseous Infiltration Revealed by ^{68}Ga-DOTA TOC PET-CT

^{68}Ga-DOTA TOC PET-CT ile Saptanan Kemik İnfiltrasyonlu Menenjiyomlar Üzerine Moleküler Perspektifler

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Abstract

Meningiomas express the somatostatin receptor (SSTR). The utilization of SSTR ligands, specifically Gallium-68 (^{68}Ga) isotope, a radioactive isotope (^{68}Ga)-DOTA-labeled peptides, has demonstrated exceptional diagnostic precision for the detection of meningiomas, primarily due to the absence of normal brain and bone activity. We report a case of a 48-year-old woman with sphenoid wing meningioma who underwent ^{68}Ga-DOTA TOC positron emission tomography (PET) for tumor delineation. ^{68}Ga-DOTA TOC PET shows SSTR-avid meningioma in the right sphenoid/anterior temporal region with significant hyperostosis with high expression of SSTR in the bone. ^{68}Ga-DOTA TOC uptake in the hyperostosis signifies bone infiltration rather than reactive changes. ^{68}Ga-DOTA PET provides a better assessment of osseous involvement and provides additional information in terms of meningioma extent and planning for further management.

Keywords: ^{68}Ga-DOTA, positron emission tomography/computed tomography, meningioma, SSTR, hyperostosis

Öz

Menenjiyomlar somatostatin reseptörü (SSTR) ekprese eder. SSTR ligandlarının, özellikle Gallium-68 (^{68}Ga)-DOTA etiketli peptitlerin kullanımı, öncelikle normal beyin ve kemik aktivitesinin olmaması nedeniyle menenjiyomları tespit etmede olağanüstü tanısal hassasiyet göstermiştir. Tümör tanımlaması için ^{68}Ga-DOTA TOC pozitron emisyon tomografisi (PET)'e tabi tutulan sfenoid kanat menenjiyomu olan 48 yaşında bir kadın olgusunu bildiriyoruz. ^{68}Ga-DOTA TOC PET, kemikte yüksek SSTR ekspresyonu ile belirgin hiperostozisli sağ sfenoid/ön temporal bölgede SSTR avid menenjiyomu göstermiştir. Hiperostozisteki ^{68}Ga-DOTA TOC tutulumu, reaksiyonel değişikliklerden ziyade kemik infiltrasyonunu ifade eder. ^{68}Ga-DOTA PET, kemik tutulumunun daha iyi değerlendirilmesini sağlar ve menenjiyomun içeriği ve daha ileri tedavi planlaması açısından ek bilgi sağlar.

Anahtar kelimeler: ^{68}Ga-DOTA pozitron emisyon tomografisi/bilgisayarlı tomografi, menenjiyom, SSTR, hiperostoz

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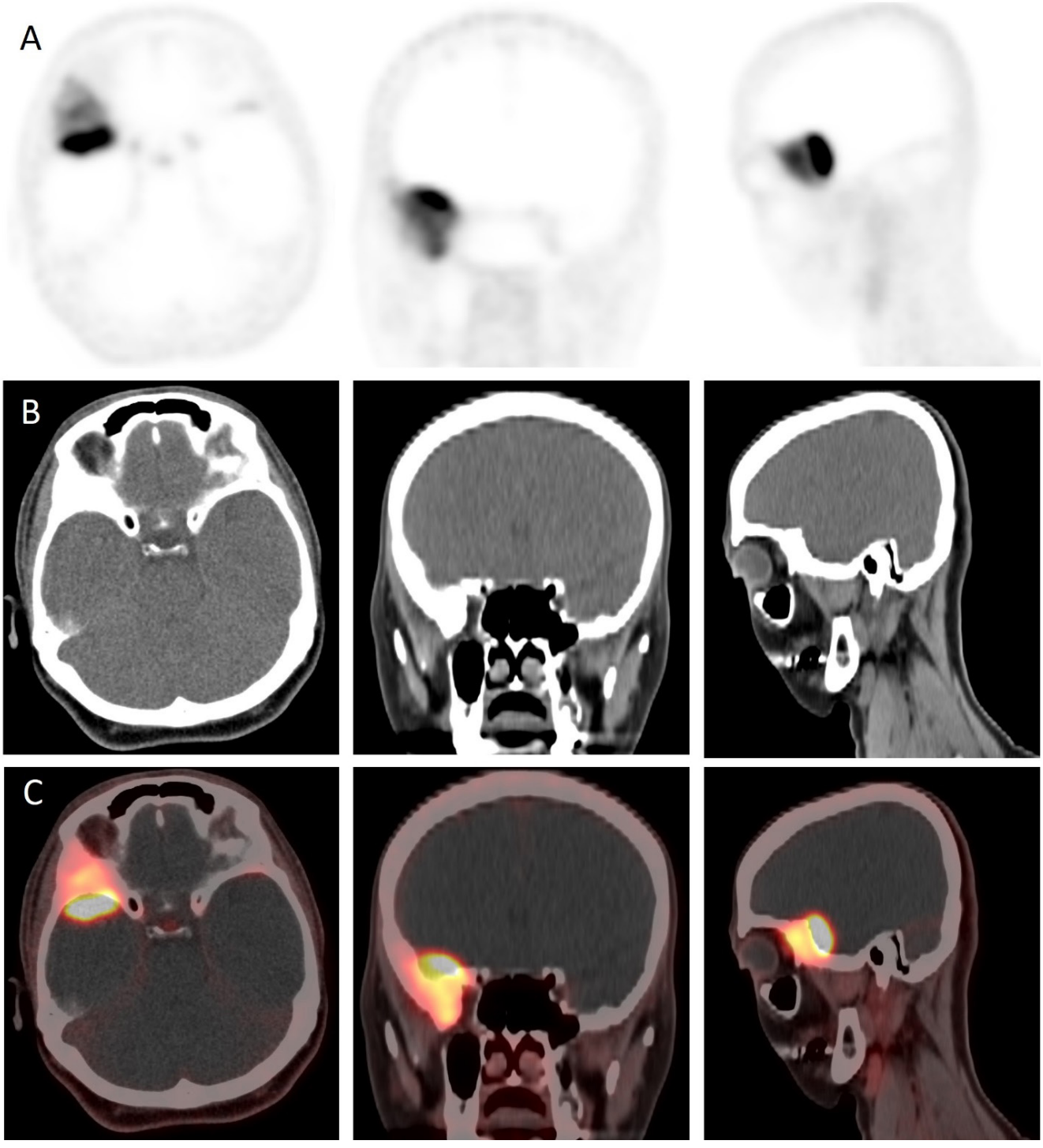

Figure 1: A 48-year-old woman with right orbital pain and swelling was diagnosed with meningioma of the right sphenoid wing on magnetic resonance imaging (MRI). Gallium-68 (^{68}Ga)-DOTA positron emission tomography/computed tomography (PET/CT) was performed for tumor delineation and lesion characterization. A-C ^{68}Ga-DOTA TOC PET/CT images demonstrate an extraaxial focal area of increased tracer uptake (SUV_{max}: 17.5) along the right sphenoid region/right anterior temporal region.

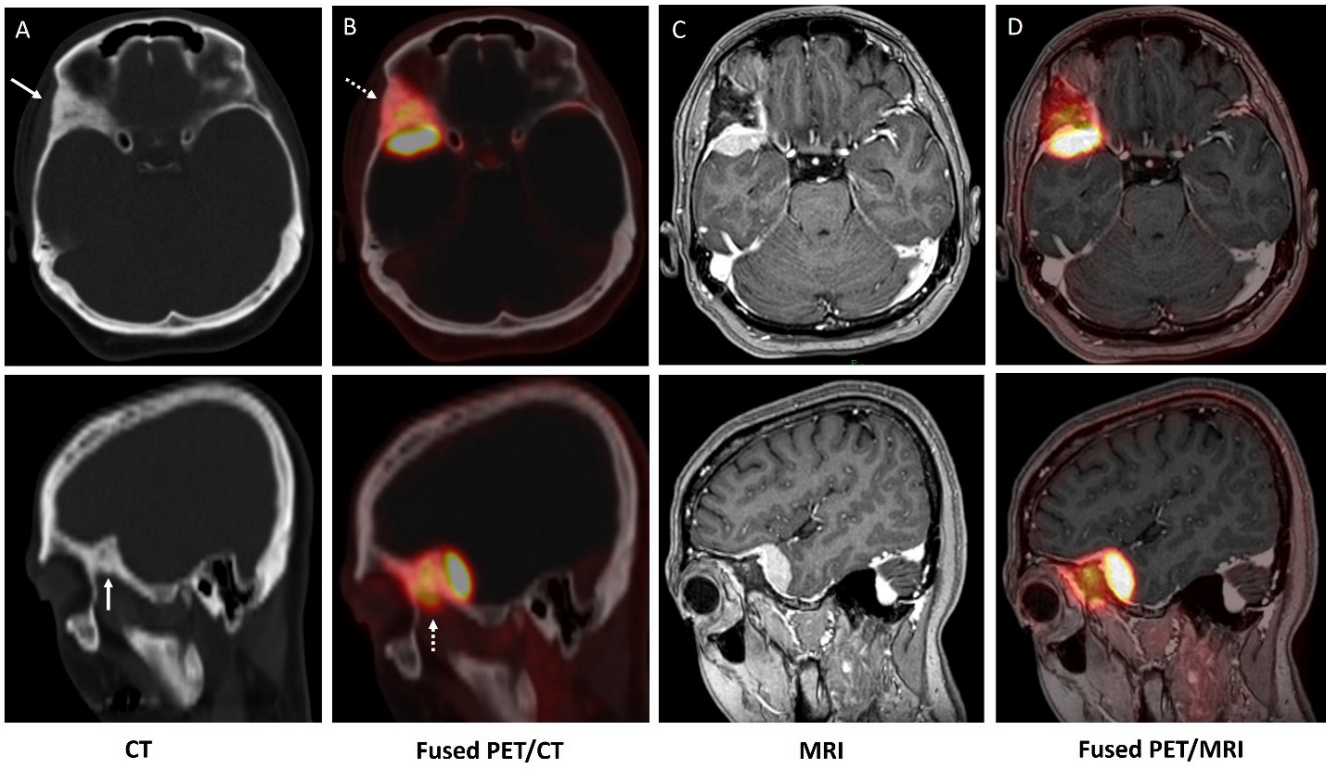

Figure 2: A. CT bone window showing expansile sclerosis (hyperostosis) mainly involving the right wing of the sphenoid bone (solid arrow), right lateral orbital wall, anterior clinoid process, and lateral wall of right sphenoid hemisinus with diffuse increased ^{68}Ga-DOTA TOC uptake of SUV_{max} 8.4 on fused images B (dashed arrow). C. MRI showing a well-defined lobulated dural-based mass arising from the greater wing of the sphenoid extending to the orbital apex. The lesion was better delineated on fused PET/MRI images (D). Findings are consistent with somatostatin receptor-avid meningioma with significant hyperostosis of the underlying bone, suggesting meningioma with bone infiltration.

Meningiomas are the most common primary brain tumors, accounting for approximately 30% of intracranial tumors (1). Bony involvement in intracranial meningiomas is uncommon and is believed to occur due to hyperostosis, which is reported to occur in 4.5%-17% of cases. Neoplastic infiltration of intracranial bone and primary intraosseous meningioma are other causative factors for bone involvement (2). It is more frequently observed in meningiomas with plaque, with an occurrence rate of 13%-49% (3). Transosseous extension of intracranial meningiomas is associated with a high risk of tumor recurrence and mortality and often requires gross total resection and cranial reconstruction (4). There is no clear mechanism underlying the hyperostotic changes that have been described in the literature. Hyperostosis may occur due to irritation from an adjacent tumor, leading to bone invasion by meningiomatosis cells, resulting in secondary hypervascularity in the diploe of the surrounding skull. Some authors have suggested that the infiltration of bone by tumor cells causes secondary changes in osteoblast and osteoclast activity, leading to increased bone deposition. A small cohort study by Matschke J et al. (5) suggests that there is high expression of somatostatin receptor 2A (SSR2A) during the histogenesis of hyperostosis in meningioma. They found that the osseous part of the tumor exhibited the same strong SSR2A reactivity as the extraosseous part of the tumor, which possibly favors bone infiltration rather than reactive changes.

Somatostatin receptor (SSTR) is a ^{68}G-protein-coupled receptor that is highly expressed in the majority of meningiomas, with subtype 2 being the most abundant (6). ^{68}Ga-DOTA PET imaging with radiolabeled somatostatin agonists offers high diagnostic accuracy for assessing meningiomas because of the high density of SSTRs. This modality provides additional information for patients exhibiting ambiguous or equivocal results on MRI. ^{68}Ga-DOTA PET delineates tumor extent more accurately than MRI with contrast, particularly in regions such as the skull base, orbital area, and parasagittal regions, where bone invasion or involvement of the dural sinuses is frequently observed (7). ^{68}Ga-DOTA PET is also more proficient in detecting osseous involvement than MRI, as the detection of osseous infiltration relies on morphologic features such as hyperostosis and intraosseous contrast enhancement (8). It is difficult to precisely define the degree of infiltration on CT and MRI images. ^{68}Ga-DOTA PET provides a better assessment of osseous involvement and has great potential to improve target delineation for surgical resection and radiation treatment planning (9). ^{68}Ga-DOTA PET can accurately determine tumor margins for radiotherapy**.** A recent study by Kowalski ES et al. (10) reported the value of ^{68}Ga-DOTATATE PET/CT in the diagnosis, radiation treatment planning, and evaluation of the response of meningiomas to radiotherapy.

Ethics

Informed Consent: Patient consent was not required for this study.

Authorship Contributions

Surgical and Medical Practices: S.F.H., J.K., Concept: S.U., A.J., K.A.R., S.F.H., S.K., Design: S.U., A.J., S.K., J.K., Data Collection or Processing: S.U., J.K., Analysis or Interpretation: S.U., S.F.H., A.J., K.A.R., S.K., Literature Search: S.U., Writing: S.U., A.J., K.A.R.

Conflict of Interest: No conflicts of interest were declared by the authors.

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