68Ga-DOTATATE PET for meningioma diagnosis

68Ga-DOTATATE PET for meningioma diagnosis has been shown to detect meningioma tissue even more sensitively than magnetic resonance imaging (MRI).

Meningioma surgery should be performed with the goal of achieving maximal safe resection, ideally guided by molecularly tagged fluorescent labeling and assessed using objective criteria, including postoperative MRI as well as molecularly tagged scans such as 68Ga-DOTATATE PET [1)].

The intraoperative Simpson Grading System is at risk to underestimate tumor remnants, predominantly in Simpson Grading System 1 and II resections. Postoperative PET-CT improves detection rates compared to MRI. Prognostic impact of postoperative meningioma remnants according to PET-CT needs to be investigated prospectively [2)]

Insufficient tracer uptake in meningiomas after intravenous application of Ga-68-DOTATATE may be safely increased by a factor of 2-5 using transfemoral selective intraarterial tracer application. [3)].

Transosseous extension of intracranial meningiomas is known to be an important risk factor for tumor meningioma recurrence and patient mortality. Kunz et al. analyzed the diagnostic performance of 68Ga-DOTATATE PET/CT and contrast-enhanced MRI (CE-MRI) for the detection of osseous infiltration using qualitative and quantitative imaging parameters. Methods: In this institutional review board-approved retrospective study, subjects were selected from 327 consecutive 68Ga-DOTATATE PET/CT examinations for evaluation of confirmed or suspected meningioma. Inclusion criteria were CE-MRI within 30 d and pathology-confirmed meningioma diagnosis with inclusion or exclusion of transosseous extension as the standard of reference. Imaging was analyzed by two readers. Tracer uptake values and meningioma volumes were determined. $\chi 2$, Mann-Whitney U, Wilcoxon signed rank, and McNemar tests, as well as receiver-operating-characteristic analyses, were performed to compare variables and diagnostic performance. Results: Eighty-two patients fulfilled the inclusion criteria. Patients with transosseous extension of meningioma (n = 67) showed significantly larger lesions (median, 12.8 vs. 3.3 mL; $P < 0.001$) and significantly higher tracer uptake values (median SUVmax, 14.2 vs. 7.6; $P = 0.011$) than patients with extraosseous meningiomas (n = 15). 68Ga-DOTATATE PET/CT in comparison to CE-MRI performed at a higher sensitivity (98.5% vs. 53.7%) while maintaining high specificity (86.7% vs. 93.3%) in the detection of osseous involvement ($P < 0.001$). In receiver-operating-characteristic analysis, PET/CT assessment performed better than CE-MRI (area under the curve, 0.932 vs. 0.773). PET/CT- and CE-MRI-based volume estimation yielded comparable results for extraosseous meningiomas ($P = 0.132$) and the extraosseous part of transosseous meningiomas ($P = 0.636$), whereas the volume of the intraosseous part was assessed as significantly larger by PET/CT ($P < 0.001$). Conclusion:68Ga-DOTATATE PET/CT enables improved detection of the transosseous extension of intracranial meningiomas compared with CE-MRI [4)].

retrospectively evaluated the safety and efficacy of somatostatin-receptor (SSTR)-targeted radionuclide therapy (177Lu-DOTATATE [n = 16], 90Y-DOTATOC [n = 3], or both [n = 1]) in patients with progressive, treatment-refractory meningiomas (5 World Health Organization [WHO] grade I, 7 WHO grade II, 8 WHO grade III) and in part multifocal disease (17 of 20 patients).

Results: SSTR radionuclide treatment (median of 3 treatment cycles, median administered dose/cycle 7400 MBq) led to a disease stabilization in 10 of 20 patients for a median time of 17 months. Stratification according to WHO grade showed a median progression-free survival (PFS) of 32.2 months for grade I tumors, 7.2 for grade II, and 2.1 for grade III. PFS at 6 months was 100% for grade I, 57% for grade II, and 0% for grade III. Median overall survival was 17.2 months in WHO grade III patients and not reached for WHO I and II at a median follow-up of 20 months. In the analysis of single meningioma lesions, maximal and mean standardized uptake values in pretherapeutic 68Ga-DOTATOC/-TATE PET/CT were significantly higher in those lesions with radiographic stability after 6 months. In line with this, high expression of SSTR via immunohistochemistry was associated with PFS >6 months.

Conclusions: SSTR-targeted radionuclide treatment has activity in a subset of patients with meningioma. Expression of SSTR via immunohistochemistry or radionuclide uptake might serve as a predictive biomarker for outcome to facilitate individualized treatment optimization in patients with uni- and multifocal meningiomas. [5)].

Twenty-one adult patients with primary (n = 12) or recurrent (n = 9) meningiomas were prospectively enrolled. Preoperative MR imaging and (68)Ga-DOTATATE PET scans were fused and used for a spatially precise neuronavigated tissue-sampling procedure during tumor resection. Histopathologic diagnosis included immunohistochemical determination of SSTR2 expression. At each individual sampling site, the maximum standardized uptake value (SUVmax) of (68)Ga-DOTATATE was correlated with MR imaging findings, histology, and semiquantitative SSTR2 expression.

Results: One hundred fifteen samples (81 tumor, 34 tumor-free) were obtained. There was a significant positive correlation between SUVmax and SSTR2 expression. Receiver-operating characteristic analysis revealed a threshold of 2.3 for SUVmax to discriminate between tumor and nontumoral tissue. Regarding the detection of tumor tissue, PET imaging showed a higher sensitivity (90% vs. 79%; P = 0.049), with specificity and positive predictive values similar to MR imaging, for both de novo and recurrent tumors.

Conclusion: (68)Ga-DOTATATE uptake correlates with SSTR2 expression and offers high diagnostic accuracy to delineate meningioma from tumor-free tissue even in recurrent tumors after previous therapy. Our findings substantiate an important role for (68)Ga-DOTATATE PET in meningioma management [6)]

Case series

Twenty-nine patients underwent DOTATATE PET/MRI meningioma evaluation in 2019. Eight patients with 9 postoperative meningiomas met RTOG 0539 intermediate-risk criteria (recurrent WHO grade I,

1/9; WHO grade II, 8/9). Target volumes were created using DOTATATE PET/MRI to determine residual disease and received a nominal dose of 35.0 Gy over 5 fractions. For comparison, cases were recontoured and planned with MRI alone per RTOG 0539 guidelines. Mean and maximum equivalent 2 Gy doses were generated for target volumes and organs at risk (OAR) within 1 cm of the PTV and compared using Wilcoxon matched pairs signed rank test.

Results: DOTATATE PET/MRI-guided planning significantly reduced mean PTV (11.12 cm3 compared to 71.39 cm3 based on MRI alone, $P < .05$) and mean and max dose to the whole brain, optic nerves, and scalp. PET/MRI plans resulted in at least 50% reduction of mean and max doses to the lens, eyes, chiasm, cochlea, brainstem, and hippocampi. One patient experienced focal alopecia. There were no local recurrences at 6 months.

Conclusion: Incorporating DOTATATE-PET/MRI for postoperative target delineation in patients with intermediate-risk intracranial meningiomas results in PTV reduction and decreased OAR dose. Our findings warrant larger studies evaluating DOTATATE-PET/MRI in the radiotherapeutic planning of postoperative meningiomas [7].

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case series of 20 patients with clinically suspected or pathology-proven meningioma evaluated between July 2018 and February 2019. [68Ga]-DOTATATE PET/MRI was obtained in order to confirm the diagnosis or determine tumor recurrence/progression to help guide surgical and/or radiation therapy management in cases in which MRI findings were indeterminate or equivocal.

Results: Seventeen (85%) patients had undergone prior surgery and 11 (55%) underwent adjuvant radiation therapy. In 17 patients [68Ga]-DOTATATE confirmed the presence of recurrent meningioma. A total of 49 meningiomas were identified (median: 2 meningiomas/patient, range 0-14). There was excellent differentiation between meningioma and posttreatment change based on our approach of target lesion/superior sagittal sinus maximum standardized uptake values ratio (16.6 vs. 1.6, $P < .0001$).

Conclusions: [68Ga]-DOTATATE PET/MRI is a promising tool in the assessment of both treatment naïve and resected/irradiated meningiomas, allowing improved diagnosis and extent of disease evaluation. Future prospective studies are needed to determine utility of [68Ga]-DOTATATE PET/MRI in treatment response assessment [8].

Case reports

68Ga-DOTATATE PET/CT confirmed the differential diagnosis of an optic sheath meningioma. The case stresses the value of the somatostatin receptor ligand PET/CT in patients with suspected optic neuritis if the diagnostic workup does not support immune-mediated pathogenesis [9].

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report a patient with an optic nerve sheath meningioma whose diagnosis and management were guided by using Gallium-68 DOTA-Tyr3-octreotatate (68Ga-DOTATATE). Positron Emission Tomography-Computed Tomography (PET-CT) [10].

Taneja et al. reported a case of a somatostatin receptor-positive extra-axial necrotizing granulomatous inflammation mimicking as meningioma on simultaneous Ga DOTATATE PET/MRI. This case illustrates a Ga DOTATATE-positive granuloma bearing a striking resemblance to meningioma. [11].

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