Clinical note

**68**Ga-DOTANOC PET/CT detection of multiple extracranial localizations in a patient with anaplastic meningioma

A. Golemi, A. Ambrosini, P. Cecchi, A. Ruiu, S. Chondrogiannis, M. Farsad, D. Rubello

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**A B S T R A C T**

We report herein a case of a 65-year-old male with intracranial recurrence of atypical meningioma initially treated with a combination of surgical resection and gamma knife radiotherapy. Afterwards, he underwent a 68Ga-DOTANOC PET/CT scan in order to evaluate the feasibility of peptide receptor radionuclide therapy (PRRT). The scan identified multiple pulmonary, pleural and lymph node localizations. Histological diagnosis was consistent with intracranial atypical meningioma with diffuse metastatic spread. In our case, we have shown that meningioma with extracranial locations may present high uptake of somatostatin receptor analogues. Among other radionuclides, we believe that 68Ga-DOTANOC PET/CT may be particularly useful for staging, detection of recurrence, evaluation of disease extension and alternative therapeutic approaches.

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**Uso de 68Ga-DOTANOC PET/TC en la detección de localizaciones extracraniales múltiples en un paciente con meningioma anaplásico**

Presentamos el caso de un varón de 65 años de edad, con recurrencia intracranal de meningioma atípico tratada inicialmente con una combinación de resección quirúrgica y radioterapia bisturi de rayos gamma. Después se sometió a una exploración 68Ga-DOTANOC PET/TC con el fin de evaluar la viabilidad de la terapia metabólica con el receptor del péptido (PRRT). Se identificaron múltiples localizaciones en pulmón, pleura y ganglios linfáticos. El diagnóstico histológico fue compatible con meningioma atípico intracraneal y diseminación metastásica difusa. Se ha demostrado con nuestro caso que meningioma con localizaciones extracraniales puede presentar alta captación de análogos de los receptores de somatostatina. Entre otros radiotrazadores creemos que 68Ga-DOTANOC PET/TC puede ser particularmente útil en la estadificación, detección de la recurrencia, la evaluación de la extensión de la enfermedad y los enfoques terapéuticos alternativos.

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**Introduction**

Intracranial meningiomas are slow-growing mostly benign neoplasms composed of neoplastic meningothelial tissue originating from the arachnoidal cap cells. With its annual incidence of six cases on 100,000 and its prevalence of 95 on 100,000 they represent the most common benign tumours of the brain. The WHO classification describes nine different histological meningioma variants and six histological variants associated with a greater risk, WHO grade II (atypical) and WHO grade III (anaplastic, papillary and rhabdoid), representing respectively 10% and 2.5% of the overall tumours.1

Malignant behaviour with distant metastatic localizations have been previously reported but therein not a common agreement about the effect of a multi-therapeutic approach.2 We report a case of a patient with intracranial meningioma and extracranial metastatic localizations and discuss the potentials of PET imaging with 68Ga-DOTA-Peptides in management of these patients.

**Case report**

A 65-year-old male with a severe headache persisting for more than 1 month was admitted to our clinic. His neurological examination was unremarkable. Cranial computed tomography (CT) first and magnetic resonance imaging (MRI) next suspected meningioma. At surgery the histological diagnosis was meningothelial meningioma WHO grade II. About 8–9% of the tumour cells were
positive for Ki-67 antigen. The patient was treated subsequently with radiation therapy. He was admitted to our hospital for 2 years later with a 10-day history of blurred vision and progressive visual impairment. MR imaging identified tumour recurrence on cerebellar tentorium, cerebral falx and right parietal lobe. He underwent a 68Ga-DOTANOC PET/CT scan for pre-therapeutic assessment of the somatostatin receptor status, as a peptide receptor radionuclide therapy (PRRT) was proposed.

68Ga-DOTANOC was produced in our radiopharmacy using standard synthesis techniques. The patient was injected i.v. with about 185 MBq of the tracer; the PET scanning was carried out 80–90 min after injection of 68Ga-DOTANOC, using a dedicated tomograph (PHILIPS GEMINI TF 16). Emission scan was acquired for 4 min at every table position, PET images were evaluated by visual inspection and semi-quantitative analysis performed by two experienced readers. Standardized uptake values (SUV) were available to the readers at the moment of reporting.

68Ga-DOTANOC PET/CT revealed increased uptake in the cerebellar tentorium, cerebral falx, right parietal lobe, both lungs and pleura and local lymph nodes (Fig. 1). Only one of the pleural nodules was studied with a CT guided biopsy (18 Gauge tru-cut biopsy needle): histopathologic findings were consistent with an atypical meningioma.

Discussion

Meningiomas are frequently reported as primary intracranial neoplasms with a benign clinical course.1 Distant localizations have been reported previously to be very rare and they occur not only in malignant tumours but, to a lesser extent, also in benign and intermediary tumours. In a recent review Surov2 reported 115 cases of malignant meningiomas with a total of 164 metastatic extracranial lesions. The most common extracranial localizations are the lung followed by liver, lymph nodes, and bones.

Surgical resection of meningiomas is the first treatment choice, but is not always feasible. As extracranial localizations of meningiomas are very rare, there are no general guidelines regarding their treatment or staging. Most distant lesions were either resected or treated in combination with local radiation.2

MRI with contrast administration is considered the gold standard imaging modality for detection and evaluation of disease extension of meningioma. Whole-body imaging methods are not routinely performed.2

There are limited data about the use of Single Photon Emission Computed Tomography (SPECT) and Positron Emission Tomography (PET) with various tracers in different clinical settings of patients with meningioma. Nuclear medicine techniques may provide complementary information to CT and MRI. There are only few reports about the use of SPECT tracers, especially Thallium-201 and 99mTc-MIBI in meningioma patients, providing information about the biological characteristics of tumour.3 PET imaging has become the preferred functional imaging method because of the better imaging properties compared to conventional nuclear medicine techniques.2 The most commonly used PET tracer, FDG, showed however limited utility in management of patients with meningioma. The FDG uptake of primary intracranial meningioma is typically low, because glucose metabolism in meningioma is similar to that of surrounding tissue. PET tracers beyond FDG, Choline, Methionine and Tyrosine, have a more favourable tumour/background ratio and allow easily the detection of intracranial meningioma. These tracers were mainly used for radiation treatment planning or grading of meningioma.3

Many studies have shown that somatostatin receptors (SSTRs) are expressed on the cell membrane of meningioma, usually with a high SSTR2 density.4 Therefore some authors suggest the use of somatostatin receptor scintigraphy (SRS) and 68Ga-DOTATOC PET-CT for preoperative evaluation of meningioma in order to increase the accuracy of surgical resection and for delineation of the target volume for external beam radiation.5,6 Furthermore in meningioma patients who had relapsed after multiple surgery or radiotherapy, or had non-operable lesions, and in whom no further treatment options were available, PRRT using 90Y-DOTA-Peptides or 177Lu-DOTA-Peptides were proposed.7 Other authors confirmed the therapeutic potential of PRRT alone or in combination with radiation therapy in patients with meningioma and

Fig. 1. (a) Fused PET/CT images and MR image show intracranial spread on both sides, left paratracheal lymphnode metastases and posterior planes of the left lung metastasis in patient with atypical meningioma. (b) 68Ga-DOTANOC PET/CT MIP image show multiple intracranial, lymph node and subpleural metastases of patient with atypical meningioma and unexpected distant metastases referred to our clinic as a candidate for peptide receptor radionuclide therapy (PRRT).
successful treatments has been reported. SRS and $^{68}$Ga-DOTANOC-Peptide PET-CT may be used as diagnostic method for selection of patients feasible for PPRT.

Our case shows that malignant meningioma with extracranial locations may present high uptake of somatostatin receptor analogues. Lanfranchi et al. in a recent paper showed multiple pulmonary and hepatic metastases using SRS. To the best of our knowledge, the current study is the only report of $^{68}$Ga-DOTANOC PET-CT detecting multiple localizations of meningioma, confirmed also by pathological examination.

In selected patients somatostatin receptor imaging may be useful for staging, detection of recurrence, evaluation of disease extension and patient selection for PPRT in patients with multiply relapsed or aggressive meningioma. PET with $^{68}$Ga-DOTANOC had high affinity for human SSTR (especially SSTR2, SSTR3, SSTR5), presents several advantages over SRS and should be potentially the method of choice in this setting.

**Conflict of interest statement**

The authors declare no conflict of interest.