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Clinical note

Radionecrosis versus disease progression in brain metastasis. Value of ^{18}F-DOPA PET/CT/MR☆

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ABSTRACT

The use of ^{18}F-DOPA PET/CT with magnetic resonance imaging fusion and the use of visual methods and quantitative analysis helps to differentiate between changes post-radiosurgery versus suspicion of disease progression in a patient with brain metastases from melanoma, thus facilitating taking early surgical action.

Radionecrosis versus progresión de la enfermedad en metástasis cerebrales: valor del ^{18}F-DOPA PET/TC/RM

Palabras clave:
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RESUMEN

La utilización del ^{18}F-DOPA PET/TC junto a la superposición con imágenes de resonancia magnética y el empleo de métodos de análisis visual y semicuantitativo permitió diferenciar entre las alteraciones posradiocirugía vs. sospecha de progresión de la enfermedad en un paciente con metástasis cerebrales de melanoma, permitiendo tomar una conducta quirúrgica correcta precozmente.

Introduction

Approximately 5–20% of patients with melanoma develop brain metastasis, presenting a poor prognosis and a mean survival of 2–5 months.[1]

Amino acid transportation is dysregulated in determined histological tumoral groups including neuroendocrine and brain tumors, and therefore these groups present overexpression in the synthesis of proteins such markers of tumoral growth and viability.[2] In the last years ^{18}F-DOPA has been proposed for the characterization of primary and secondary brain lesions because of its high concentrations in tumor cells and low concentrations in normal brain tissue (except for basal lymph nodes).[3]

^{18}F-DOPA was first used in patients with Parkinson disease and has recently been applied in tumoral processes.[4] The fundament is based on ^{18}F-DOPA being an analog of L-DOPA, and L-DOPA enters the cells of the nigrostriatal pathway through the amino acid transport system where it is later transformed into dopamine by the action of L-DOPA decarboxylase.[4]

For evaluating tumoral lesions in the central nervous system, PET and MR fusion studies can not only provide morphological characterization of the lesions but also allow the segmentation and quantification of these lesions using specific software tools which improve the sensitivity and specificity of the method.[5]

We present the case of a patient with brain metastasis due to melanoma who was previously treated with radiosurgery and with difficult characterization of the lesions using conventional imaging methods (MR).

Clinical case

A 70-year-old patient with no previous history of interest was diagnosed with stage IV melanoma (single lung metastasis successfully removed 12 months previously). The patient presented relapse at a cerebral parenchyma level showing 2 lesions in the right

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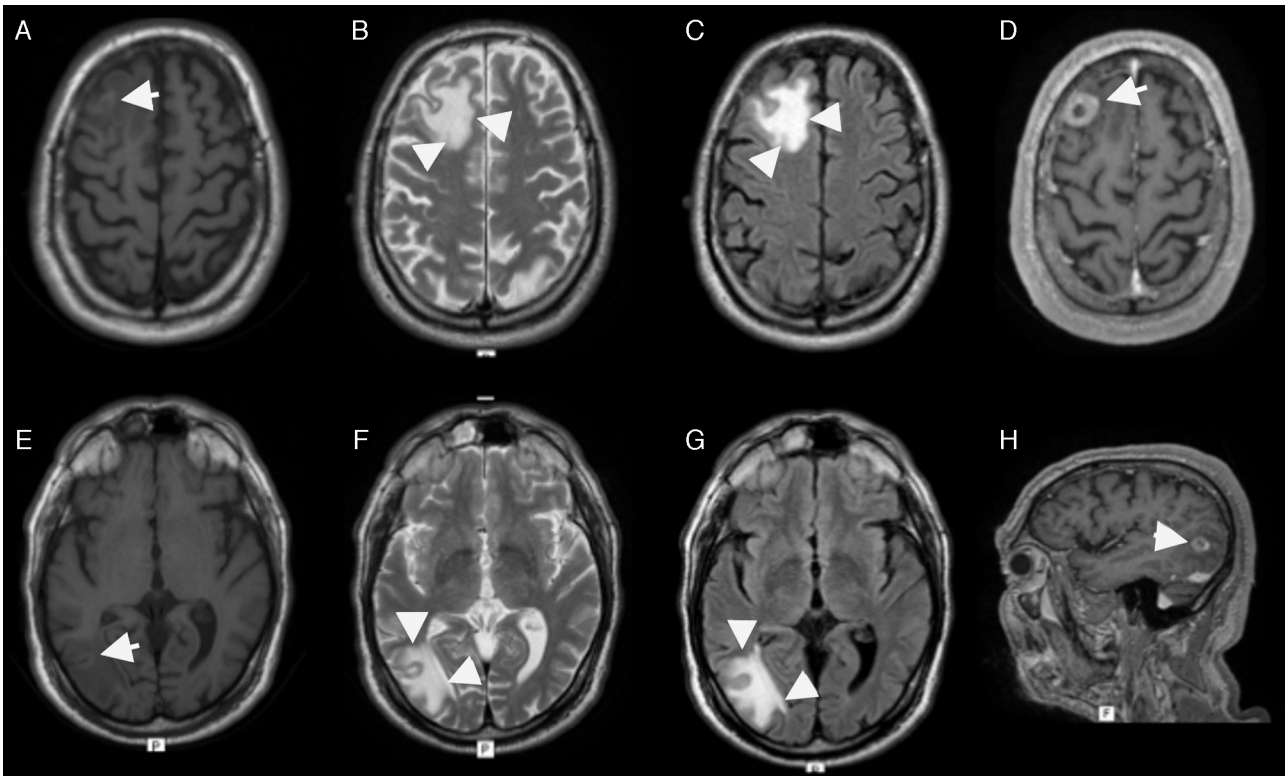

Fig. 1. Two lesions of the brain parenchyma are shown: one right frontal and the other right occipital (arrows in A, D, E and H). The lesions show slightly increased uptake in T1 (A and E) and increased uptake in T2 (B and F) as well as in FLAIR (C and G), showing ring-shaped uptake after the injection of gadolinium (D and H). Note the edema of the perilesional parenchyma (arrowheads in B, C, F, G).

frontal and temporal regions which were treated by radiosurgery (gamma knife).

At 5 and 6 months after surgery MR and spectroscopy controls showed an increase in the size of the lesions but could not conclusively differentiate between disease progression (DP) and radionecrosis (RN) (Fig. 1). An ^{18}F-DOPA PET/CT/MR study was therefore proposed. Molecular images were acquired in Philips Gemini 64 TF PET/CT equipment (Philips Medical Systems, OH, USA). The patient received 150 mg of carbidopa 60 min before the injection of 186.1 MBq (1.85 MBq/kg) of the radiotracer, and static images were acquired 60 min post-injection. Volumetric cerebral sequences (T1) were also made using Philips Achieva 1.5 T MR equipment (Philips Medical Systems, The Netherlands).

The PET images (corrected for attenuation) were fused with the MR images of the patient using the PNEURO 3.6® software (Fig. 2). The MR volume was spatially normalized to the Hammers atlas,[6] allowing the structures of interest (left and left neostriate) to be automatically segmented and then the results were placed in the patient space (Fig. 3). The anatomical volume was obtained as well as functional information [i.e.: standardized uptake value (SUV)] from the structures which were segmented in the PET/MR images. The regions of interest (ROI) were manually determined including the frontal and occipital lesions in the PET images in order to obtain the maximum uptake values in each case ($SUVL_{max}$). The ROI were moved to the respective contralateral sectors of both lesions to obtain the maximum background uptake ($Bkgr_{max}$) in each case. We performed the following quantitative analyses of the lesions according to the results obtained by Cicone et al.[7] as shown in Table 1:

1. The maximum uptakes of each lesion and those of the corresponding contralateral regions ($SUVL_{max}/Bkgr_{max}$) were both higher than the cut off of 1.59 described by Cicone et al. to differentiate DP from RN.
2. Likewise, the numerical relationship of the maximum uptake of both lesions and that corresponding to the total neostriate ($SUVL_{max}/Ne_{max}$) was, in both cases, higher than the cut off of 0.75 established by Cicone et al.

Table 1
Values of the uptake of the lesions.

Lesion	$SUVL_{max}/Bkgr_{max}$	$SUVL_{max}/Ne_{max}$
Frontal	2.70	1.21
Occipital	2.72	1.28

Quantitative analysis indicated DP. Surgical resection of the lesions was therefore performed, and the histological analysis was compatible with progression of brain metastasis.

Discussion

It is a diagnostic challenge to radiologically differentiate DP from RN since both present common symptoms and morphological characteristics in MR images (high signal in T2 and FLAIR, enhancement with the intravenous contrast and perilesional edema, among others) and function [diffusion weighted image (DWI), abnormal diffusion restriction (ADC), spectroscopy and perfusion].

The lesion signal in cases of RN evaluated with DWI is usually bright similar to what is observed in tumoral lesions, although the value is higher with ADC. In turn, spectroscopy shows a variable decrease in the NAA/creatine relationship in the two entities, with an increase in the choline/creatine relationship and the presence of lipids being characteristic in cases of DP.[8]

Evaluation by MR brain perfusion techniques shows an increase in the relative cerebral blood volume (rCBV) expressing